TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
A Teledyne Technologies Company

OPERATOR'S MANUAL

MODEL 703E
PHOTOMETRIC O_3 CALIBRATOR

© TELEDYNE INSTRUMENTS
ADVANCED POLLUTION INSTRUMENTATION DIVISION
(TAPI)
9480 CARROLL PARK DRIVE
SAN DIEGO, CALIFORNIA 92121-5201
USA

Toll-free Phone:	**800-324-5190**
Phone:	**858-657-9800**
Fax:	**858-657-9816**
Email:	**api-sales@teledyne.com**
Website:	**http://www.teledyne-api.com/**

Copyright 2007
Teledyne Advanced Pollution Instrumentation

05743 Rev. C
DCN 5521
29 July 2009

THIS PAGE IS INTENTIONALLY LEFT BLANK

PRINTED DOCUMENTS ARE UNCONTROLLED.

We recommend that this document be read in its entirety before any attempt is made to operate the instrument.

DOCUMENTS

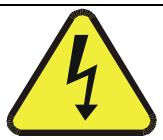
Document P/N	Revision	DCN	Nomenclature	Dated
05743	B	5359	M703, Manual, Instruction - Title	03/20/09
05744	B	5359	M703, Manual, Instruction - Text	03/20/09
05745	C	5359	M703, Appendix A, Menu Tree	03/20/09
05746	B	5359	M703, Appendix B, Spare Parts	03/20/09
05747	B	5359	M703, Appendix C, Repair Form	03/20/09
05748	B	5359	M703, Appendix D, Schematics	03/20/09
05834	F	5359	List, Spare Parts, M703	03/20/09
05863	B	5359	List, Recommended Spares Stocking Levels, M703	03/20/09
05834	J	5480	List, Spare Parts, M703	07/15/09
05863	D	5480	List, Recommended Spares Stocking Levels, M703	07/15/09

THIS PAGE IS INTENTIONALLY LEFT BLANK

SAFETY MESSAGES

Your safety and the safety of others are very important. We have provided many important safety messages in this manual. Please read these messages carefully.

A safety message alerts you to potential hazards that could hurt you or others. Each safety message is associated with a safety alert symbol. These symbols are found in the manual and inside the M703E Photometric O3 Calibrator. The definition of these symbols is described below:

	GENERAL SAFETY HAZARD: Refer to the instructions for details on the specific hazard.
	CAUTION: Hot Surface Warning.
	**CAUTION: Electrical Shock Hazard.**
	TECHNICIAN SYMBOL: All operations marked with this symbol are to be performed by qualified maintenance personnel only.

CAUTION

The M703E Photometric O3 Calibrator should only be used for the purpose and in the manner described in this manual. If you use the M703E in a manner other than that for which it was intended, unpredictable behavior could ensue with possible hazardous consequences.

NOTE

Technical Assistance regarding the use and maintenance of the M703E or any other Teledyne Instruments product can be obtained by:

Contacting Teledyne Instruments' Customer Service Department at 800-324-5190

or

Via the internet at http://www.teledyne-api.com/forms

USER NOTES:

TABLE OF CONTENTS

GENERAL INFORMATION 1
1. INTRODUCTION 3
1.1. M703E calibrator Overview 3
1.2. Using This Manual 3
2. SPECIFICATIONS, APPROVALS AND WARRANTY 5
2.1. Specifications 5
2.2. CE Mark Compliance 6
2.3. Warranty 7
3. GETTING STARTED 9
3.1. Unpacking and Initial Setup 9
3.1.1. Model 703E calibrator 10
3.2. Electrical Connections 13
3.2.1. Power Connection 13
3.2.2. Analog output TEST CHANNEL Connections 13
3.2.3. Connecting the Status Outputs 14
3.2.4. Connecting the Control Inputs 15
3.2.5. Connecting the Control Outputs 17
3.2.6. Connecting the Serial Ports 18
3.2.7. Connecting to a LAN or the Internet 18
3.2.8. Connecting to a Multidrop Network 18
3.3. Pnenumatic Connections 19
3.3.1. Dry Air In 19
3.3.2. Zero Air In 19
3.3.3. Output Manifold 20
3.3.4. Exhaust 20
3.3.5. Measuring An External Ozone Source 20
3.4. Initial Operation 21
3.4.1. START-UP 21
3.4.2. Warm Up 22
3.4.3. Warning Messages 22
3.4.4. Functional Check 24
3.4.5. Operating Modes for the O_3 Generator 25
3.4.5.1. CNST (CONSTANT) 25
3.4.5.2. REF (REFERENCE) 25
3.4.5.3. BNCH (BENCH) 25
3.4.6. Setting the O3 Generator Mode 25
3.4.7. Setting the M703E's output Flow Rate 26
4. FREQUENTLY ASKED QUESTIONS AND GLOSSARY 27
4.1. FAQ's 27
4.2. Glossary 27
5. OPTIONAL HARDWARE AND SOFTWARE 29
5.1. Carrying Strap Handle (OPT 29) 29
5.2. Communication Options 30
5.2.1. RS232 Modem Cables (OPTs 60 and 60A) 30
5.2.2. ETHERNET Cable (OPT 60B) 30
5.2.3. RS-232 Multidrop (OPT 62) 30
5.2.4. Ethernet (OPT 63) 31
5.2.5. Ethernet + Multidrop (OPT 64) 32
5.3. Additional Manual (OPT 70) 32
5.4. Extended Warranty (OPT 92) 32
5.5. NIST Traceable, Primary Standard CERTIFICATION 32
OPERATING INSTRUCTIONS 33
6. OPERATING THE M703E CALIBRATOR 35
6.1. Test Functions 36

6.2. Overview of Operating modes 37
6.3. STANDBY Mode 38
6.4. General Information about the GENERATE mode 39
6.4.1. GENERATE → AUTO: Basic Generation of Calibration Gas 39
6.5. AUTOMATIC CALIBRATION SEQUENCES 40
6.5.1. SETUP → SEQ: Programming Calibration Sequences 40
6.5.1.1. Activating a Sequence from the M703E Front Panel 41
6.5.1.2. Naming a Sequence 42
6.5.1.3. Setting the Repeat Count for a Sequence 43
6.5.1.4. Using the M703E's Internal Clock to Trigger Sequences 44
6.5.1.5. Setting Up Control Inputs for a Sequence 47
6.5.1.6. Setting Up Control Outputs for a Sequence 48
6.5.1.7. Setting the PROGRESS Reporting Mode for the Sequences 49
6.5.2. Adding Sequence Steps 50
6.5.2.1. The Generate Step 51
6.5.2.2. The STANDBY Step 52
6.5.2.3. The DURATION Step 52
6.5.2.4. The EXECSEQ Step 53
6.5.2.5. The CC OUTPUT Step 54
6.5.2.6. Deleting or Editing an Individual Step in a Sequence 55
6.5.3. Deleting a Sequence 56
6.6. SETUP → CFG 57
6.7. SETUP → CLK 58
6.7.1. Setting the internal Clock's Time and Day 58
6.7.2. Adjusting the internal Clock's speed 59
6.8. SETUP → PASS 60
6.9. SETUP → DIAG → TEST CHAN OUTPUT: Using the TEST Channel Analog Output 62
6.9.1. Configuring the TEST CHANNEL Analog Output 62
6.9.1.1. The Analog I/O Configuration Submenu. 62
6.9.1.2. Selecting a Test Channel Function to Output 64
6.9.1.3. TEST CHANNEL VOLTAGE RANGE Configuration 66
6.9.1.4. Turning the TEST CHANNEL Over-Range Feature ON/OFF 67
6.9.1.5. Adding a Recorder Offset to the TEST CHANNEL 68
6.9.2. TEST CHANNEL CALIBRATION 69
6.9.2.1. Enabling or disabling the TEST CHANNEL Auto-Cal Feature 69
6.9.2.2. Automatic TEST CHANNEL Calibration 70
6.9.2.3. Manual Calibration of the TEST CHANNEL configured for Voltage Ranges 72
6.9.3. AIN Calibration 74
6.10. SETUP → MORE → VARS: Internal Variables (VARS) 75
6.11. Operating the M703E Calibrator as an O_3 Photometer 77
6.11.1. Set up for Operating the M703E as an O_3 Photometer 77
6.12. SETUP → LVL: Setting up and using LEADS (Dasibi) Operating Levels 79
6.12.1. General Information about LEADS LEVELS 79
6.12.2. Dot commands 79
6.12.3. Levels 80
6.12.4. Activating an existing LEVEL 80
6.12.5. Programming New LEVELS 81
6.12.5.1. Creating a GENERATE LEVEL 82
6.12.5.2. Creating a MANUAL LEVEL 83
6.12.5.3. Editing or Deleting a LEVEL 84
6.12.6. Configuring LEVEL Status Blocks 86
7. OPERATING THE M703E OVER THE SERIAL I/O PORTS 87
7.1. Using the Analyser's Communication Ports 87
7.1.1. RS-232 DTE and DCE Communication 87
7.1.2. COMM Port Default Settings and Connector Pin Assignments 88
7.1.3. COMM Port Baud Rate 90
7.1.4. COMM Port Communication Modes 91
7.1.5. COMM Port Testing 93

7.1.6. Machine ID 94
7.1.7. Terminal Operating Modes 95
7.1.7.1. Help Commands in Terminal Mode 95
7.1.7.2. Command Syntax 96
7.1.7.3. Data Types 96
7.1.7.4. Status Reporting 97
7.1.7.5. COM Port Password Security 98
7.2. Remote Access by Modem 99
7.3. Multidrop RS-232 Set Up 101
7.4. RS-485 Configuration of COM2 103
7.5. Remote Access via the Ethernet 105
7.5.1. Ethernet Card COM2 Communication Modes and Baud Rate 105
7.5.2. Configuring the Ethernet Interface Option using DHCP 105
7.5.2.1. Manually Configuring the Network IP Addresses 108
7.5.3. Changing the Calibrator's HOSTNAME 110
7.6. APICOM Remote Control Program 111
8. M703E CALIBRATION AND VERIFICATION 113
8.1. Verifying and Calibrating the M703E's O_3 Photometer 113
8.1.1. Setup for VERIFYING AND calibrating the O_3 Photometer 113
8.1.1.1. Calibration Manifold Exhaust/Vent Line 114
8.1.2. Verifying O_3 Photometer Performance 115
8.1.3. Calibrating the O_3 Photometer 116
8.1.3.1. Photometer Zero Calibration 116
8.1.3.2. Photometer Span Calibration 117
8.1.4. O_3 Photometer Dark Calibration 118
8.2. Calibrating the O_3 Generator 119
8.2.1. O3 Generator Calibration table 119
8.2.2. Viewing O_3 Generator Calibration Points 120
8.2.3. Adding or Editing O_3 Generator Calibration Points 121
8.2.4. Deleting O_3 Generator Calibration Points 122
8.2.5. Turning O_3 Generator Calibration Points ON / OFF 123
8.2.6. Performing an Automatic Calibration of the O_3 Generator 124
8.3. M703E Gas Pressure Sensor Calibration 125
8.3.1.1. Gas Pressure Sensor Calibration Set Up 125
8.3.2. Calibrating the Regulator and Photometer Pressure Sensors 127
8.4. M703E Gas Flow Calibration 128
8.4.1. Calibrating the Photometer's Sample Gas Flow 129
8.4.2. Calibrating the OuTput Gas Flow 130
8.4.2.1. Output Gas Flow Set Up 130
8.4.2.2. Performing an Output Gas Flow Calibration 131
TECHNICAL INFORMATION 133
9. THEORY OF OPERATION 135
9.1. Pneumatic Operation 135
9.1.1. Gas Flow Control 135
9.1.1.1. Flow Control Assemblies 135
9.1.1.2. Photometer Critical Flow Orifice 135
9.1.2. Internal Gas Pressure Sensors 136
9.2. Electronic Operation 137
9.2.1. Overview 137
9.2.2. CPU 138
9.2.2.1. Disk On Chip 139
9.2.2.2. Flash Chip 139
9.2.3. Relay PCA 140
9.2.3.1. Valve Control 141
9.2.3.2. Heater Control 141
9.2.3.3. Relay PCA Status LEDs & Watch Dog Circuitry 141
9.2.3.4. Relay PCA Watchdog Indicator (D1) 142

9.2.4. Motherboard 143
9.2.4.1. A to D Conversion 143
9.2.4.2. Sensor Inputs 143
9.2.4.3. Thermistor Interface 143
9.2.4.4. Analog Outputs 143
9.2.4.5. External Digital I/O 144
9.2.4.6. I^2C Data Bus 144
9.2.4.7. Power-up Circuit 144
9.2.5. Power Supply and Circuit Breaker 145
9.2.6. AC Power Configuration 146
9.2.6.1. AC configuration – Internal Pump (JP7) 146
9.3. Front Panel Interface 147
9.3.1.1. Calibrator Status LEDs 148
9.3.1.2. Keyboard 148
9.3.1.3. Display 148
9.3.1.4. Keyboard/Display Interface Electronics 149
9.4. Software Operation 150
9.5. O_3 generator operation 151
9.5.1. Principle of Photolytic O_3 Generation 151
9.5.2. Generator Pneumatic Operation 152
9.5.3. O_3 Generator Electronic Operation 152
9.5.3.1. O_3 Generator Temperature Control 154
9.6. Photometer Operation 155
9.6.1. Measurement Method 155
9.6.1.1. Calculating O_3 Concentration 155
9.6.1.2. The Measurement / Reference Cycle 156
9.6.1.3. The Absorption Path 158
9.6.1.4. Interferent Rejection 158
9.6.2. Photometer Layout 159
9.6.3. Photometer Pneumatic Operation 159
9.6.4. Photometer Electronic Operation 160
9.6.4.1. O_3 Photometer Temperature Control 160
9.6.4.2. Pneumatic Sensors for the O_3 Photometer 161
10. MAINTENANCE SCHEDULE & PROCEDURES 163
10.1. Maintenance Schedule 163
10.2. Performing Leak Checks 167
10.2.1. Pressure Leak Check 167
10.3. Cleaning or replacing the Absorption Tube 171
10.4. Rebuilding the Dry Air Pump 171
10.5. Photometer UV Source Lamp Adjustment 172
10.6. Photometer UV Source Lamp Replacement 173
10.7. Adjustment or Replacement of Ozone Generator UV Lamp 174
11. GENERAL TROUBLESHOOTING & REPAIR OF THE M703E CALIBRATOR 177
11.1. General Troubleshooting 177
11.1.1. Fault Diagnosis with WARNING Messages 178
11.1.2. Fault Diagnosis With Test Functions 180
11.1.3. Using the Diagnostic Signal I/O Function 182
11.2. Using the Analog Output Test Channel 183
11.3. Using the Internal Electronic Status LEDs 184
11.3.1. CPU Status Indicator 184
11.3.2. Relay PCA Status LEDs 184
11.3.2.1. I^2C Bus Watchdog Status LEDs 184
11.3.2.2. O_3 Status LEDs 185
11.4. Subsystem Checkout 186
11.4.1. Verify Subsystem Calibration 186
11.4.2. AC Main Power 186
11.4.3. DC Power Supply 187

11.4.4. I^2C Bus 188
11.4.5. Keyboard/Display Interface 188
11.4.6. Relay PCA 189
11.4.7. PHOTOMETER O3 Generator Pressure /FLOW SENSOR Assembly 189
11.4.8. Motherboard 191
11.4.8.1. A/D Functions 191
11.4.8.2. Test Channel / Analog Outputs Voltage 191
11.4.8.3. Status Outputs 192
11.4.8.4. Control Inputs 193
11.4.8.5. Control Outputs 194
11.4.9. CPU 194
11.4.10. RS-232 Communications 195
11.4.10.1. General RS-232 Troubleshooting 195
11.4.10.2. Troubleshooting Calibrator/Modem or Terminal Operation 195
11.4.11. Temperature Problems 196
11.4.11.1. Box / Chassis Temperature 196
11.4.11.2. Photometer Sample Chamber Temperature 196
11.4.11.3. UV Lamp Temperature 196
11.4.11.4. Ozone Generator Temperature 197
11.5. Troubleshooting the O_3 photometer 197
11.5.1. Dynamic Problems with the O_3 photometer 197
11.5.1.1. Noisy or Unstable O_3 Readings at Zero 197
11.5.1.2. Noisy, Unstable, or Non-Linear Span O_3 Readings 198
11.5.1.3. Slow Response to Changes in Concentration 198
11.5.1.4. The Analog Output Signal Level Does Not Agree With Front Panel Readings 198
11.5.1.5. Cannot Zero 198
11.5.1.6. Cannot Span 198
11.5.2. Checking Measure / REFERENCE VALVE 199
11.6. Troubleshooting the O_3 Generator 200
11.6.1. Checking The UV Lamp Power Supply 200
11.7. Trouble Shooting the Optional O_3 generator 201
11.7.1. Checking The UV Source Lamp Power Supply 201
11.8. Repair Procedures 202
11.8.1. Repairing Sample Flow Control Assembly 202
11.8.2. Disk-On-Chip Replacement Procedure 203
11.9. Technical Assistance 203
12. A PRIMER ON ELECTRO-STATIC DISCHARGE 205
12.1. How Static Charges are Created 205
12.2. How Electro-Static Charges Cause Damage 206
12.3. Common Myths About ESD Damage 207
12.4. Basic Principles of Static Control 207
12.4.1. General Rules 207
12.4.2. Basic anti-ESD Procedures for Analyzer Repair and Maintenance 209
12.4.2.1. Working at the Instrument Rack 209
12.4.2.2. Working at an Anti-ESD Work Bench. 209
12.4.2.3. Transferring Components from Rack to Bench and Back 210
12.4.2.4. Opening Shipments from Teledyne Instruments Customer Service. 210
12.4.2.5. Packing Components for Return to Teledyne Instruments Customer Service 211

LIST OF FIGURES

Figure 3-1: M703E Front Panel Layout 10
Figure 3-2: M703E Rear Panel Layout 10
Figure 3-3: M703E Internal Layout – Top View 11
Figure 3-4: M703E Pneumatic Diagram 12
Figure 3-5: M703E the TEST CHANNEL Connector 13
Figure 3-6: Status Output Connector 14
Figure 3-7: M703E Digital Control Input Connectors 16
Figure 3-8: M703E Digital Control Output Connector 17
Figure 3-9: Basic Pneumatic Setup of M703E 19
Figure 3-10: Location of Pressure Regulator Adjustment Knob 26
Figure 5-1: M703E with Carrying Strap Handle and Rack Mount Brackets 29
Figure 5-1: M703E Multidrop Card 30
Figure 5-2: M703E Ethernet Card 31
Figure 5-3: M703E Rear Panel with Ethernet Installed 31
Figure 6-1: Front Panel Display 37
Figure 6-2: M703E the TEST CHANNEL Connector 62
Figure 6-3: Setup for Calibrating the TEST CHANNEL 72
Figure 6-4: Set up for Using the M703E to Measure an External O_3 Source 77
Figure 6-5: LEADS Level Display Format 85
Figure 7-1: Default Pin Assignments for Back Panel COMM Port connectors (RS-232 DCE & DTE) 88
Figure 7-2: Default Pin Assignments for CPU COM Port connector (RS-232). 88
Figure 7-3: Location of JP2 on RS232-Multidrop PCA (option 62) 101
Figure 7-4: RS232-Multidrop PCA Host/Calibrator Interconnect Diagram 102
Figure 7-5: CPU card Locations of RS-232/485 Switches, Connectors and Jumpers 103
Figure 7-6: Back Panel connector Pin-Outs for COM2 in RS-485 mode. 104
Figure 7-7: CPU connector Pin-Outs for COM2 in RS-485 mode 104
Figure 7-8: APICOM Remote Control Program Interface 111
Figure 8-1: Set up for Verifying Optional O_3 Photometer Using Internal O_3 Generator 114
Figure 8-2: Set up for Verifying Optional O_3 Photometer Using an External O_3 Generator 114
Figure 8-3: Pressure Calibration Monitor Points 125
Figure 8-4: O_3 Generator Pressure Monitor Point Physical Location– M703E 126
Figure 8-5: Output Flow Calibration Monitor Point 130
Figure 9-1: Location of Gas Flow Control Assemblies 135
Figure 9-2: M703E Electronic Block Diagram 137
Figure 9-3: M703E CPU Board Annotated 138
Figure 9-4: Relay Board PCA with AC Relay Retainer Removed 140
Figure 9-5: Heater Control Loop Block Diagram. 141
Figure 9-6: Status LED Locations – Relay PCA 141
Figure 9-7: M703E Power Distribution Block diagram 145
Figure 9-8: Location of the AC Configuration Jumper for the Dry Air Pump 146
Figure 9-9: Pump AC Power Jumpers (JP7) 147
Figure 9-10: M703E Front Panel Layout 147
Figure 9-11: Keyboard and Display Interface Block Diagram 149
Figure 9-12: Schematic of Basic Software Operation 150
Figure 9-13: O_3 Generator Internal Pneumatics 151
Figure 9-14: O_3 Generator Valve and Gas Fixture Locations 152
Figure 9-15: O_3 Generator Electronic Block Diagram 153
Figure 9-16: O_3 Generator Electronic Components Location 153
Figure 9-17: O_3 Generator Temperature Thermistor and DC Heater Locations 154
Figure 9-18: O_3 Photometer Gas Flow – Measure Cycle 157
Figure 9-19: O_3 Photometer Gas Flow – Reference Cycle 157
Figure 9-20: O_3 Photometer Absorption Path 158
Figure 9-21: O_3 Photometer Layout – Top Cover Removed 159
Figure 9-22: O_3 Photometer Electronic Block Diagram 160
Figure 10-2: Pneumatic setup for performing Pressure Leak Checks 170
Figure 10-3: Photometer – Location of UV Detector Gain Adjustment & UV Lamp Set Screw 173

Figure 10-4: O_3 Generator Temperature Thermistor and DC Heater Locations 174
Figure 10-5: Location of O_3 Generator Reference Detector Adjustment Pot 174
Figure 11-1: Example of Signal I/O Function 182
Figure 11-2: CPU Status Indicator 184
Figure 11-3: Relay PCA Status LEDS Used for Troubleshooting 185
Figure 11-4: Location of DC Power Test Points on Relay PCA 187
Figure 11-5: Critical Flow Restrictor Assembly Disassembly 202
Figure 12-1: Triboelectric Charging 205
Figure 12-2: Basic anti-ESD Work Station 207

LIST OF TABLES

Table 2-1: M703E Analytical Specifications 5
Table 2-2: M703E Electrical and Physical Specifications 5
Table 2-3: M703E Specifications for Ozone Generator 6
Table 2-4: M703E Specifications for O_3 Photometer 6
Table 3-1: Status Output Pin Assignments 14
Table 3-2: M703E Control Input Pin Assignments 15
Table 3-3: M703E Control Input Pin Assignments 17
Table 3-4: Front Panel Display during System Warm-Up 22
Table 3-5: Possible Warning Messages at Start-Up 23
Table 6-1: Test Functions Defined 36
Table 6-2: Calibrator Operating Modes 37
Table 6-3: Automatic Calibration SEQUENCE Set Up Attributes 40
Table 6-4: Calibration SEQUENCE Step Instruction 40
Table 6-5: Sequence Progress Reporting Mode 49
Table 6-6: Password Levels 60
Table 6-7: DIAG - Analog I/O Functions 62
Table 6-8: Test Channels Functions Available on the M703E's Analog Output 64
Table 6-9: Analog Output Voltage Range Min/Max 66
Table 6-10: Voltage Tolerances for the TEST CHANNEL Calibration 72
Table 6-11: Variable Names (VARS) 75
Table 7-1: COMM Port Communication Modes 91
Table 7-2: Terminal Mode Software Commands 95
Table 7-3: Teledyne Instruments Serial I/O Command Types 96
Table 7-4: Ethernet Status Indicators 105
Table 7-5: LAN/Internet Configuration Properties 106
Table 8-1: M703E Pressure Sensors 125
Table 8-2: M703E Gas Pressure to Output Flow conversion Table 128
Table 9-1: Relay Board Status LEDs 142
Table 9-2: AC Power Configuration for Internal Pumps (JP7) 146
Table 9-3: Front Panel Status LEDs 148
Table 9-4: M703E Photometer Measurement / Reference Cycle 156
Table 10-1: M703E Maintenance Schedule 165
Table 11-1: Front Panel Warning Messages 179
Table 11-2: Test Functions - Indicated Failures 180
Table 11-3: Test Channel Outputs as Diagnostic Tools 183
Table 11-4: Relay PCA Watchdog LED Failure Indications 184
Table 11-5: Relay PCA Status LED Failure Indications 185
Table 11-6: DC Power Test Point and Wiring Color Codes 187
Table 11-7: DC Power Supply Acceptable Levels 188
Table 11-8: Relay PCA Control Devices 189
Table 11-9: Analog Output Test Function - Nominal Values Voltage Outputs 192
Table 11-10: Status Outputs Check 192
Table 11-11: M703E Control Input Pin Assignments and Corresponding Signal I/O Functions 193

Table 11-12: Control Outputs Pin Assignments and Corresponding Signal I/O Functions Check 194
Table 12-1: Static Generation Voltages for Typical Activities 205
Table 12-2: Sensitivity of Electronic Devices to Damage by ESD 206

LIST OF APPENDICES

APPENDIX A - VERSION SPECIFIC SOFTWARE DOCUMENTATION

APPENDIX A-1: Model 703E Software Menu Trees, Revision C.0

APPENDIX A-2: Model 703E Setup Variables Available Via Serial I/O, Revision C.0

APPENDIX A-3: Model 703E Warnings and Test Measurements via Serial I/O, Revision C.0

APPENDIX A-4: Model 703E Signal I/O Definitions, Revision C.0

APPENDIX A-5: Model 703E Terminal Command Designators, Revision C.0

APPENDIX B - Model 703E SPARE PARTS LIST

APPENDIX C - Model 703E REPAIR QUESTIONNAIRE

APPENDIX D - Model 703E ELECTRONIC SCHEMATICS

USER NOTES:

USER NOTES:

SECTION I
–
GENERAL INFORMATION

USER NOTES

1. INTRODUCTION

1.1. M703E CALIBRATOR OVERVIEW

The Model 703E is a microprocessor-based ozone calibrator for calibration of ambient ozone analyzers, such as the T-API M400E. The M703E features an internal ozone photometer that provides very accurate closed loop feedback control of the ozone concentration.

As many as 50 independent calibration sequences may be programmed into the M703E, covering time periods of up to one year. The setup of sequences is simple and intuitive. These sequences may be actuated manually, automatically, or by a remote signal. The sequences may be uploaded remotely, including remote editing. All programs are maintained in non-volatile memory.

The M703E design emphasizes fast response, repeatability, overall accuracy and ease of operation. It may be combined with the Model 701 Zero Air Generator to provide the ultimate in easy to use, precise calibration for your ozone analyzers.

Some of the exceptional features of your M703E Photometric O3 Calibrator are:

- Advanced E Series electronics
- Lightweight for transportability
- Optional Ethernet connectivity
- 12 independent timers for sequences
- Nested sequences (up to 5 levels)
- Internal ozone generator and photometer allows use as primary or transfer standard

1.2. USING THIS MANUAL

NOTE

Throughout this manual, words printed in capital, bold letters, such as SETUP or ENTR represent messages as they appear on the calibrator's display.

This manual is organized in the following manner:

TABLE OF CONTENTS:

Outlines the contents of the manual in the order the information is presented. This is a good overview of the topics covered in the manual. There is also a list of appendices, figures and tables. In the electronic version of the manual, clicking on any of these table entries automatically views that section.

SECTION I – GENERAL INFORMATION

INTRODUCTION
A brief description of the M703E calibrator architecture as well as a description of the layout of the manual and what information is located in its various sections and chapters.

SPECIFICATIONS AND WARRANTY
Teledyne Instruments' warranty statement.

GETTING STARTED
Instructions for setting up, installing and running your calibrator for the first time.

GLOSSARY:
Answers to the most frequently asked questions about operating the calibrator and a glossary of acronyms and technical terms.

OPTIONAL HARDWARE & SOFTWARE
A description of optional equipment to add functionality to your calibrator.

SECTION II – OPERATING INSTRUCTIONS

USING THE M703E CALIBRATOR
Step-by-Step instructions for using the display/keyboard to set up and operate the M703E calibrator.

REMOTE OPERATION OF THE M703E CALIBRATOR
Information and instructions for interacting with the M703E calibrator via its several remote interface options (e.g. via RS-232, Ethernet, its built in digital control inputs/outputs, etc.)

M703E VALIDATION AND VERIFICATION
Methods and procedures for validating and verifying the correct operation of your M703E Photometric O3 Calibrator

SECTION III – TECHNICAL INFORMATION

THEORY OF OPERATION
An in-depth look at the various principals by which your calibrator operates as well as a description of how the various electronic, mechanical and pneumatic components of the calibrator work and interact with each other. A close reading of this section is invaluable for understanding the calibrator's operation.

MAINTENANCE SCHEDULE AND PROCEDURES
Description of preventative maintenance procedures that should be regularly performed on you calibrator to assure good operating condition.

GENERAL TROUBLESHOOTING & REPAIR OF THE M703E CALIBRATOR
This section includes pointers and instructions for diagnosing problems with the calibrator in general as well as instructions on performing repairs.

A PRIMER ON ELECTRO-STATIC DISCHARGE
This section describes how static electricity occurs; why it is a significant concern and; how to avoid it and avoid allowing ESD to affect the reliable and accurate operation of your calibrator.

APPENDICES

For easier access and better updating, some information has been separated out of the manual and placed in a series of appendices at the end of this manual. These include version-specific software menu trees, warning messages, serial I/O variables as well as spare part listings, repair questionnaires, interconnect drawing, detailed pneumatic and electronic schematics.

USER NOTES:

2. SPECIFICATIONS, APPROVALS AND WARRANTY

2.1. SPECIFICATIONS

Table 2-1: M703E Analytical Specifications

Linearity	+/- 1.0% of full scale
Precision	1.0 ppb
Stability	+/- 2.0 ppb (photometer feedback mode)
Response Time	180 seconds to 95%
Stability (7-days)	1% photometer feedback; 3% without photometer feedback (CNST or REF)

Table 2-2: M703E Electrical and Physical Specifications

Temperature Range	5-40ºC
Humidity Range	0 - 95% RH, non-condensing
Dimensions (HxWxD)	7" (178 mm) x 17" (432 mm) x 24" (609 mm)
Operating Altitude	10,000 ft Maximum
Weight	35.5 lbs (16.1 kg) including internal zero air pump
AC Power	115VAC, 60Hz 230VAC,50HZ
Analog Outputs	1 user configurable output
Analog Output Ranges	0.1 V, 1 V, 5 V or 10 V Range with 5% under/over-range
Analog Output Resolution	1 part in 4096 of selected full-scale voltage (12 bit)
Digital Control Outputs	12 opto-isolated outputs
Digital Control Inputs	12 opto-isolated outputs
Status Outputs	12 opto-isolated outputs, 5 defined, 7 spare
Serial I/O	2 ports: 1x RS-232; 1x RS-485 or RS-232 (configurable) Communication speed: 300 - 115200 baud (user selectable)
Certifications	EN61326 (1997 w/A1: 98) Class A, FCC Part 15 Subpart B Section 15.107 Class A, ICES-003 Class A (ANSI C63.4 1992) & AS/NZS 3548 (w/A1 & A2; 97) Class A. IEC 61010-1:90 + A1:92 + A2:95,

Table 2-3: M703E Specifications for Ozone Generator

Maximum Output	6 ppm LPM
Minimum Output	100 ppb LPM
Response Time:	180 Sec. (98%)
Optical Feedback	Standard

Table 2-4: M703E Specifications for O_3 Photometer

Full Scale Range	100 ppb to 10 ppm ; User Selectable
Precision	1.0 ppb
Linearity	1.0% of Full Scale
Rise/Fall Time	<20 sec (photometer response)
Zero Drift	<1.0 ppb / 7 days
Span Drift	<1% / 24 hours; <2% / 7 days
Minimum Gas Flow Required	800 cc^3/min

2.2. CE MARK COMPLIANCE

EMISSIONS COMPLIANCE

The Teledyne Instruments' M703E Photometric O3 Calibrator is designed to be fully compliant with:

EN61326 (1997 w/A1: 98) Class A, FCC Part 15 Subpart B Section 15.107 Class A, ICES-003 Class A (ANSI C63.4 1992) & AS/NZS 3548 (w/A1 & A2; 97) Class A.

Test status: Pending.

SAFETY COMPLIANCE

The Teledyne Instruments' M703E Photometric O3 Calibrator is designed to be fully compliant with:

IEC 61010-1:90 + A1:92 + A2:95,

Test status: Pending.

2.3. WARRANTY

WARRANTY POLICY (02024D)

Prior to shipment, T-API equipment is thoroughly inspected and tested. Should equipment failure occur, T-API assures its customers that prompt service and support will be available.

COVERAGE

After the warranty period and throughout the equipment lifetime, T-API stands ready to provide on-site or in-plant service at reasonable rates similar to those of other manufacturers in the industry. All maintenance and the first level of field troubleshooting is to be performed by the customer.

NON-API MANUFACTURED EQUIPMENT

Equipment provided but not manufactured by T-API is warranted and will be repaired to the extent and according to the current terms and conditions of the respective equipment manufacturers warranty.

GENERAL

During the warranty period, T-API warrants each Product manufactured by T-API to be free from defects in material and workmanship under normal use and service. Expendable parts are excluded.

If a Product fails to conform to its specifications within the warranty period, API shall correct such defect by, in API's discretion, repairing or replacing such defective Product or refunding the purchase price of such Product.

The warranties set forth in this section shall be of no force or effect with respect to any Product: (i) that has been altered or subjected to misuse, negligence or accident, or (ii) that has been used in any manner other than in accordance with the instruction provided by T-API, or (iii) not properly maintained.

THE WARRANTIES SET FORTH IN THIS SECTION AND THE REMEDIES THEREFORE ARE EXCLUSIVE AND IN LIEU OF ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE OR OTHER WARRANTY OF QUALITY, WHETHER EXPRESSED OR IMPLIED. THE REMEDIES SET FORTH IN THIS SECTION ARE THE EXCLUSIVE REMEDIES FOR BREACH OF ANY WARRANTY CONTAINED HEREIN. API SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR RELATED TO THIS AGREEMENT OF T-API'S PERFORMANCE HEREUNDER, WHETHER FOR BREACH OF WARRANTY OR OTHERWISE

TERMS AND CONDITIONS

All units or components returned to Teledyne Instruments Incorporated should be properly packed for handling and returned freight prepaid to the nearest designated Service Center. After the repair, the equipment will be returned, freight prepaid.

USER NOTES:

USER NOTES:

3. GETTING STARTED

3.1. UNPACKING AND INITIAL SETUP

CAUTION

THE M703E WEIGHS ABOUT 16.1 KG (35.5 POUNDS) WITHOUT OPTIONS INSTALLED. TO AVOID PERSONAL INJURY, WE RECOMMEND USING TWO PERSONS TO LIFT AND CARRY THE CALIBRATOR.

1. Inspect the received packages for external shipping damage. If damaged, please advise the shipper first, then Teledyne Instruments.

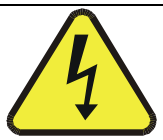
2. Included with your calibrator is a printed record of the final performance characterization performed on your instrument at the factory. This record, titled Final Test and Validation Data Sheet (P/N 05760) is an important quality assurance and calibration record for this instrument. It should be placed in the quality records file for this instrument.

3. Carefully remove the top cover of the calibrator and check for internal shipping damage.
   - Remove the set-screw located in the top, center of the Front panel.
   - Remove the 2 screws fastening the top cover to the unit (one per side towards the rear).
   - Slide the cover backwards until it clears the calibrator's front bezel.
   - Lift the cover straight up.

NOTE

Printed circuit assemblies (PCAs) are sensitive to electro-static discharges too small to be felt by the human nervous system. Failure to use ESD protection when working with electronic assemblies will void the instrument warranty.

See Chapter 12 for more information on preventing ESD damage.



CAUTION

NEVER DISCONNECT ELECTRONIC CIRCUIT BOARDS, WIRING HARNESSES OR ELECTRONIC SUBASSEMBLIES WHILE THE UNIT IS UNDER POWER.

4. Inspect the interior of the instrument to make sure all circuit boards and other components are in good shape and properly seated.

5. Check the connectors of the various internal wiring harnesses and pneumatic hoses to make sure they are firmly and properly seated.

6. Verify that all of the optional hardware ordered with the unit has been installed. These are checked on the paperwork accompanying the calibrator.

VENTILATION CLEARANCE: Whether the calibrator is set up on a bench or installed into an instrument rack, be sure to leave sufficient ventilation clearance.

AREA	MINIMUM REQUIRED CLEARANCE
Back of the instrument	10 cm / 4 inches
Sides of the instrument	2.5 cm / 1 inch
Above and below the instrument.	2.5 cm / 1 inch

Various rack mount kits are available for this calibrator. See Chapter 5 of this manual for more information.

3.1.1. MODEL 703E CALIBRATOR

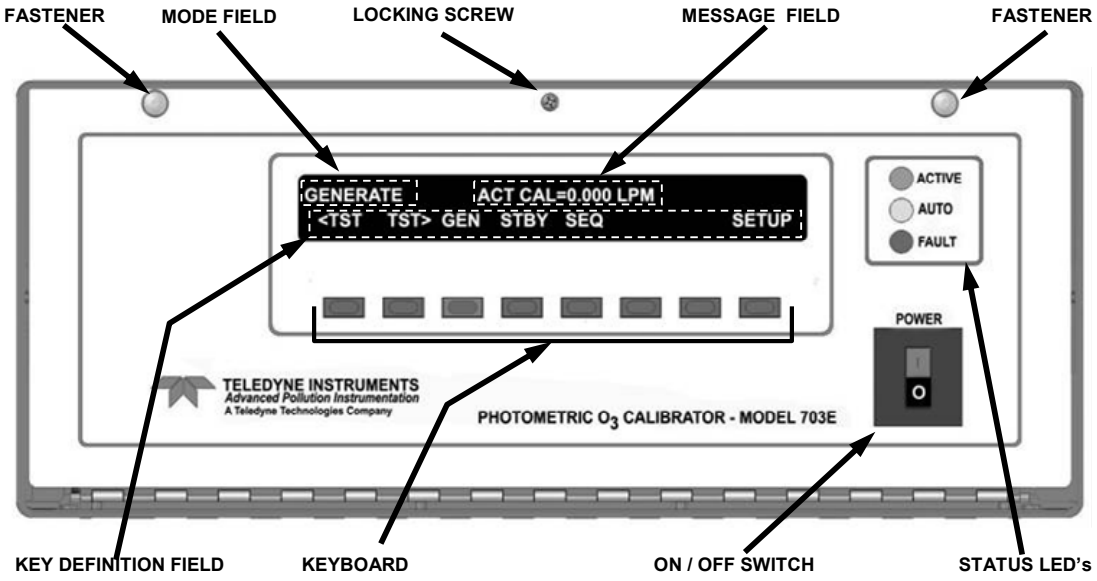


Figure 3-1: M703E Front Panel Layout

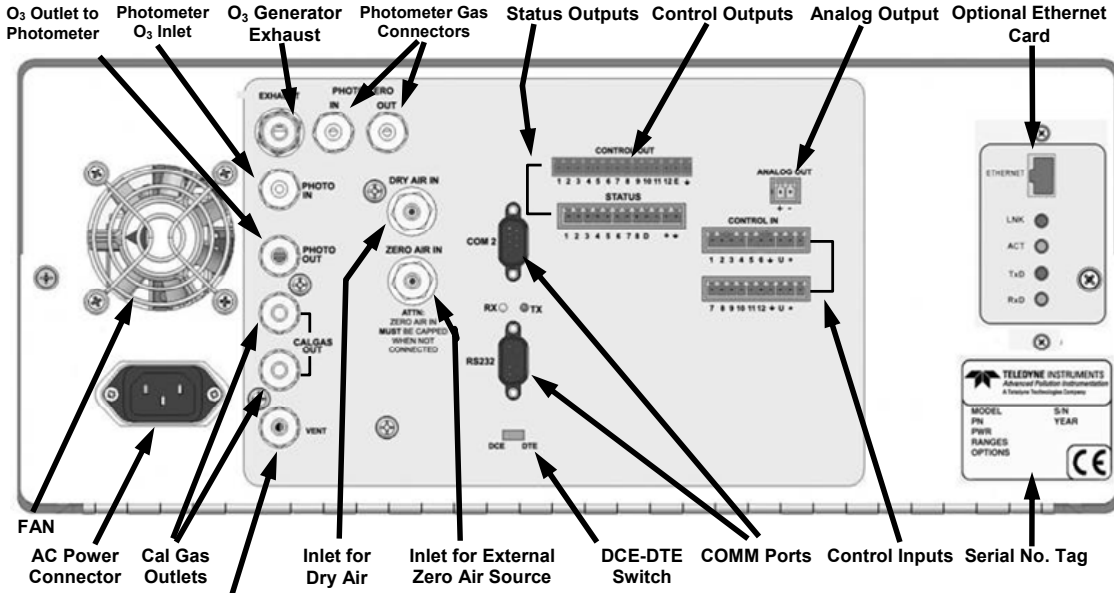


Figure 3-2: M703E Rear Panel Layout

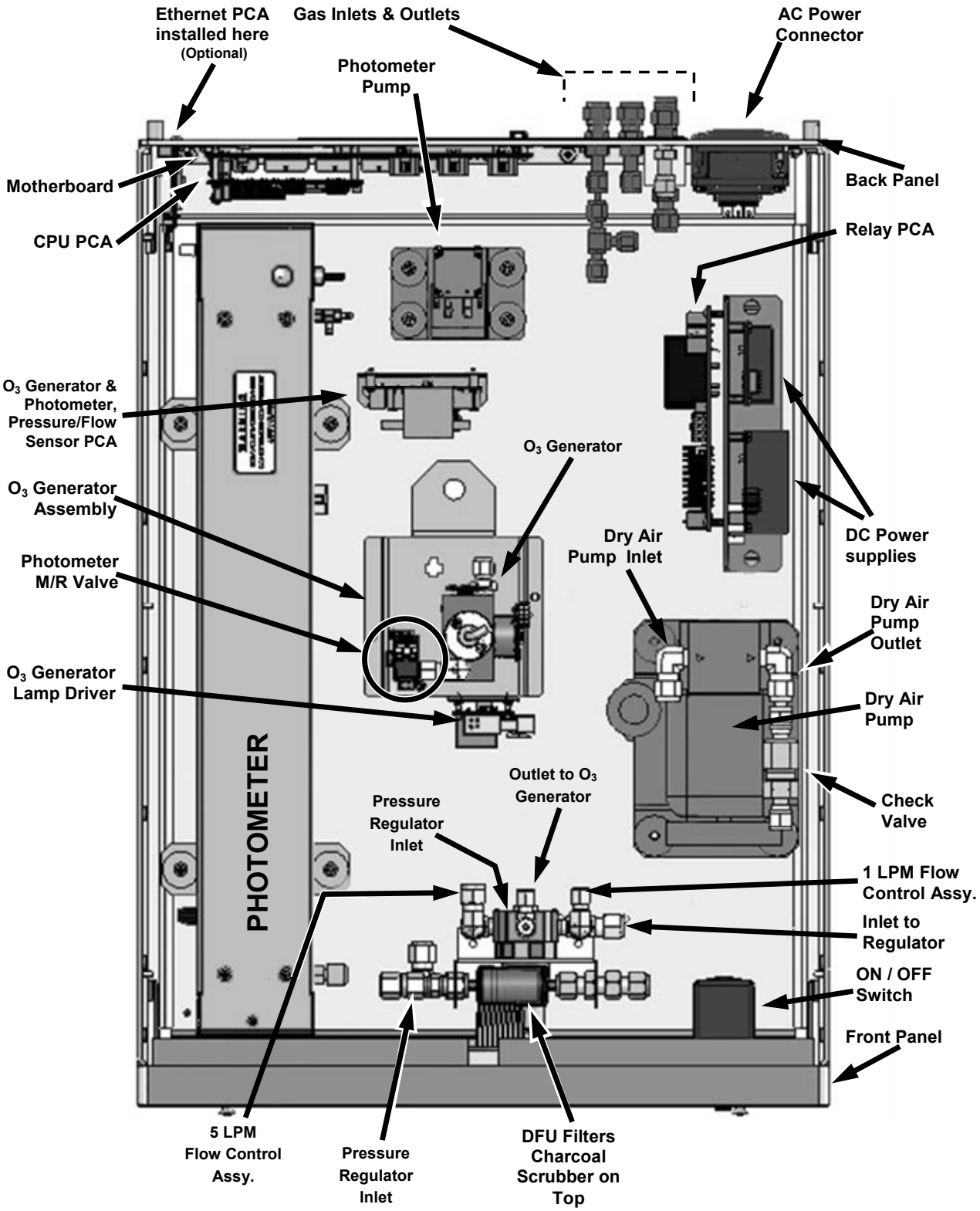


Figure 3-3: M703E Internal Layout – Top View

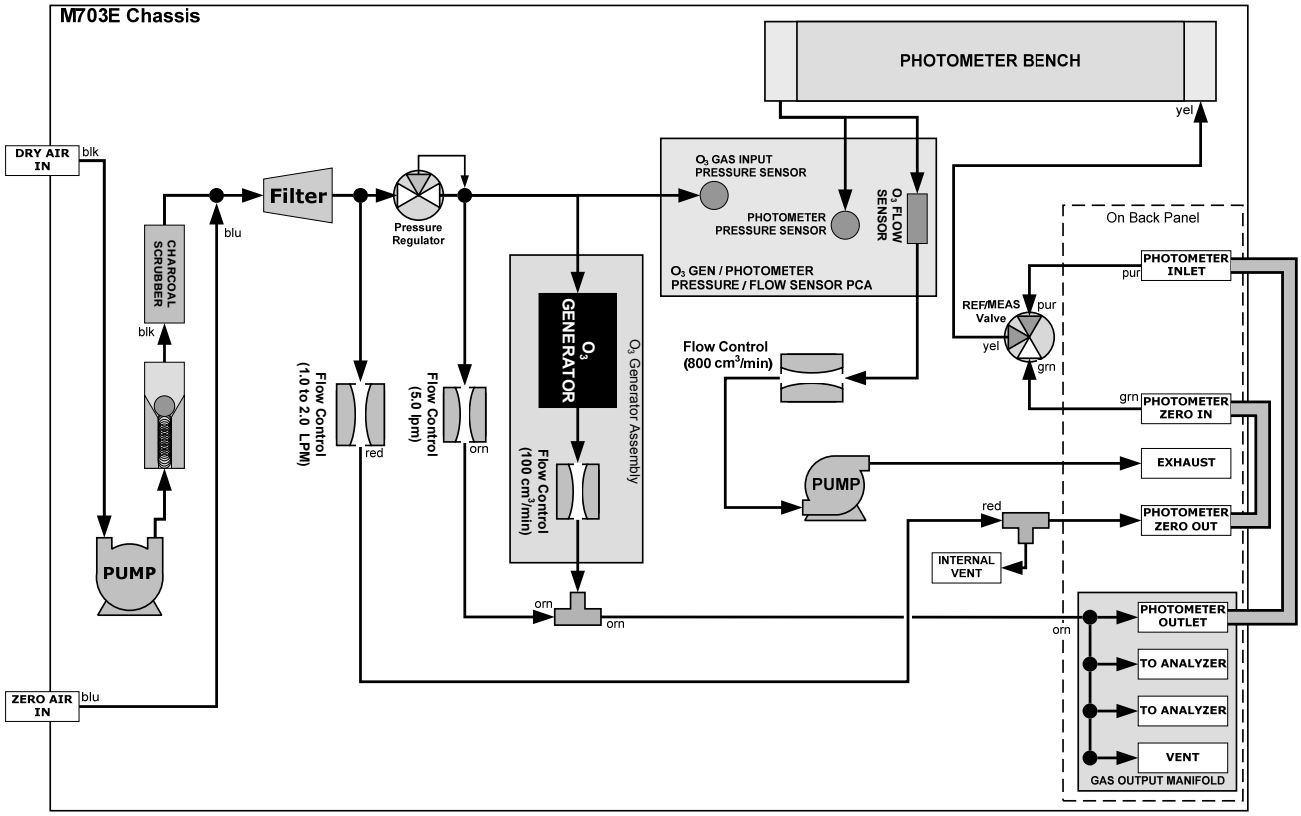


Figure 3-4: M703E Pneumatic Diagram

3.2. ELECTRICAL CONNECTIONS

3.2.1. POWER CONNECTION

Verify the correct line voltage and frequency configuration on the serial number tag on the rear panel of the M703E.

Attach the power cord to the calibrator and plug it into a power outlet capable of carrying at least 10 A current at your AC voltage and that it is equipped with a functioning earth ground.

CAUTION

HIGH VOLTAGES ARE PRESENT INSIDE THE CALIBRATORS CASE

POWER CONNECTION MUST HAVE FUNCTIONING GROUND CONNECTION.

DO NOT DEFEAT THE GROUND WIRE ON POWER PLUG.

TURN OFF CALIBRATOR POWER BEFORE DISCONNECTING OR CONNECTING ELECTRICAL SUBASSEMBLIES.

CAUTION

DO NOT LOOK AT THE PHOTOMETER UV LAMP.

UV LIGHT CAN CAUSE EYE DAMAGE.

ALWAYS WEAR GLASSES MADE FROM SAFETY UV FILTERING GLASS (PLASTIC GLASSES WILL NOT DO).

3.2.2. ANALOG OUTPUT TEST CHANNEL CONNECTIONS

The M703E is equipped with an analog output channel accessible through a connector on the back panel of the instrument. The standard configuration for this output is 0-5 VDC. It can be set by the user to output one of a variety of diagnostic test functions (see Section 6.9.)

To access these signals attach a strip chart recorder and/or data-logger to the appropriate analog output connections on the rear panel of the calibrator.

Pin-outs for the analog output connector at the rear panel of the instrument are:

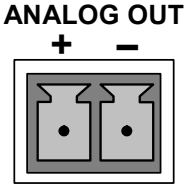


Figure 3-5: M703E the TEST CHANNEL Connector

3.2.3. CONNECTING THE STATUS OUTPUTS

The status outputs report calibrator conditions via optically isolated NPN transistors, which sink up to 50 mA of DC current. These outputs can be used interface with devices that accept logic-level digital inputs, such as programmable logic controllers (PLC's). Each Status bit is an open collector output that can withstand up to 40 VDC. All of the emitters of these transistors are tied together and available at D.

NOTE

Most PLC's have internal provisions for limiting the current that the input will draw from an external device. When connecting to a unit that does not have this feature, an external dropping resistor must be used to limit the current through the transistor output to less than 50 mA. At 50 mA, the transistor will drop approximately 1.2V from its collector to emitter.

The status outputs are accessed via a 12-pin connector on the calibrator's rear panel labeled STATUS. The function of each pin is defined in Table 3-1.

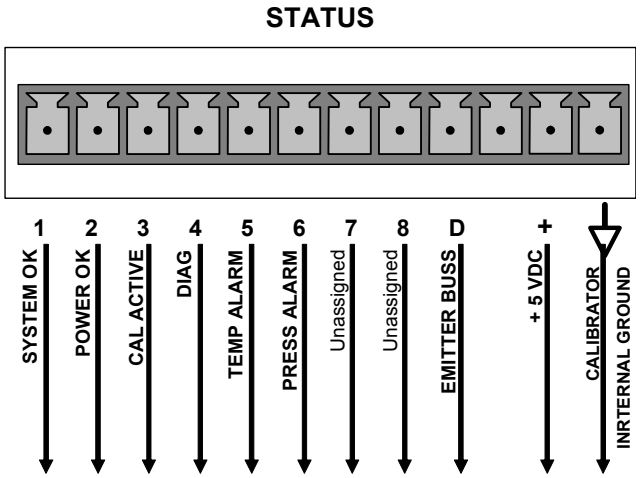


Figure 3-6: Status Output Connector

The pin assignments for the Status Outputs are:

Table 3-1: Status Output Pin Assignments

OUTPUT #	STATUS DEFINITION	CONDITION
1	**SYSTEM OK**	On, if no faults are present.
2	Unassigned	
3	**CAL ACTIVE**	On if the calibrator is in **GENERATE** mode
4	**DIAG**	On if the calibrator is in **DIAGNOSTIC** mode
5	**TEMP ALARM**	On whenever a temperature alarm is active.
6	**PRESS ALARM**	On whenever gas pressure alarm is active
7 & 8	Unassigned	
D	Emitter BUSS	The emitters of the transistors on pins 1 to 8 are bussed together.
⏚	Digital Ground	The ground level from the calibrator's internal DC power supplies.
D	Emitter BUSS	The emitters of the transistors on pins 9 to 16 are bussed together.
+	DC POWER	+ 5 VDC

3.2.4. CONNECTING THE CONTROL INPUTS

The calibrator is equipped with 12 digital control inputs that can be used to Initiate various user programmable calibration sequences (see Section 6.5.1.5 for instructions on assigning the control inputs to specific calibration sequences).

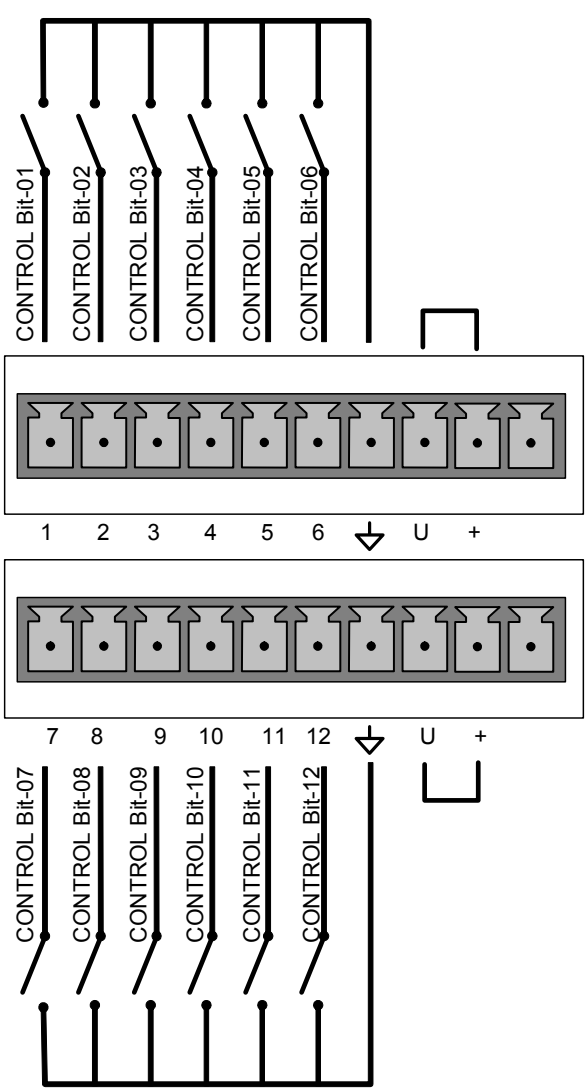
Access to these inputs is via 2 separate 10-pin connectors, labeled CONTROL IN, that are located on the calibrator's rear panel.

Table 3-2: M703E Control Input Pin Assignments

CONNECTOR	INPUT	DESCRIPTION
Top	**1 to 6**	Can be used as either 6 separate on/off switches or as bits 1 through 6 of a 12 bit wide binary activation code (see Section 6.5.1.5)
Bottom	**7 to 12**	Can be used as either 6 separate on/off switches or as bits 7 through 12 of a 12 bit wide binary activation code (see Section 6.5.1.5)
BOTH	⏚	Chassis ground.
Top	**U**	Input pin for +5 VDC required to activate pins A – F. This can be from an external source or from the "+" pin of the instruments STATUS connector.
Bottom	**U**	Input pin for +5 VDC required to activate pins G – L. This can be from an external source or from the "+" pin of the instruments STATUS connector.
BOTH	**+**	Internal source of +5V that can be used to actuate control inputs when connected to the U pin.

There are two methods for energizing the control inputs. The internal +5V available from the pin labeled "+" is the most convenient method. However, if full isolation is required, an external 5 VDC power supply should be used.

Example of Local Power Connections



Example of External Power Connections

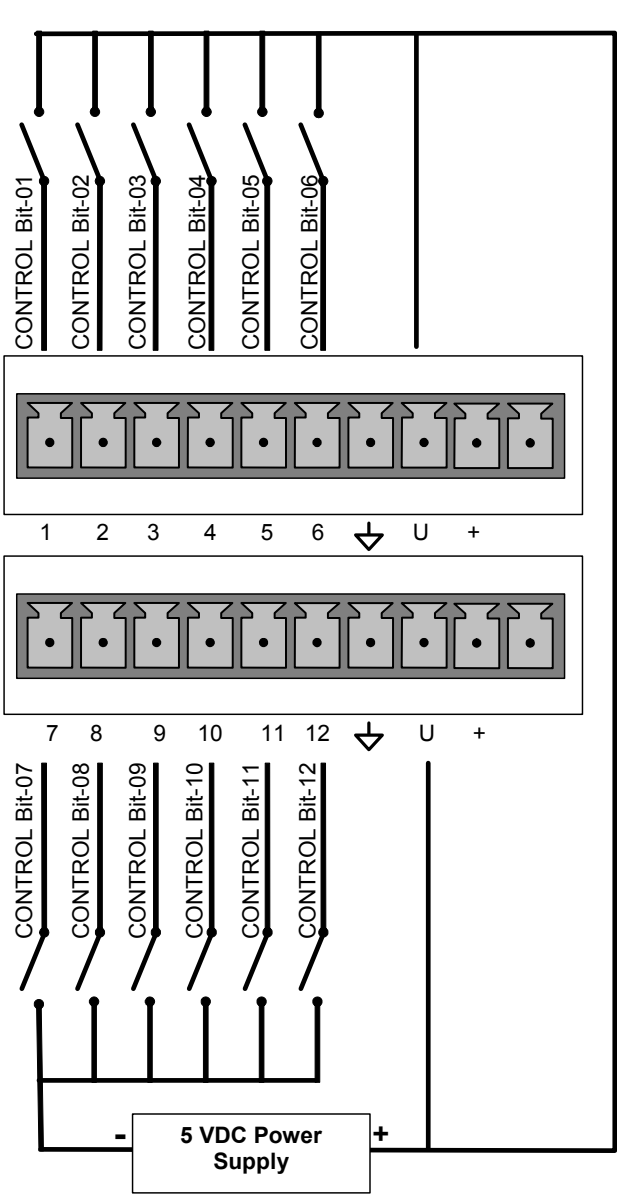


Figure 3-7: M703E Digital Control Input Connectors

3.2.5. CONNECTING THE CONTROL OUTPUTS

The calibrator is equipped with 12 opto-isolated, digital control outputs. These outputs are activated by the M703E's user-programmable, calibration sequences (see Section 6.5.1.6 for instructions on assigning the control outputs to specific calibration sequences)

These outputs may be used to interface with devices that accept logic-level digital inputs, such as programmable logic controllers (PLC's), dataloggers, or digital relays/valve drivers.

They are accessed via a 14-pin connector on the calibrator's rear panel (see Figure 3-2).

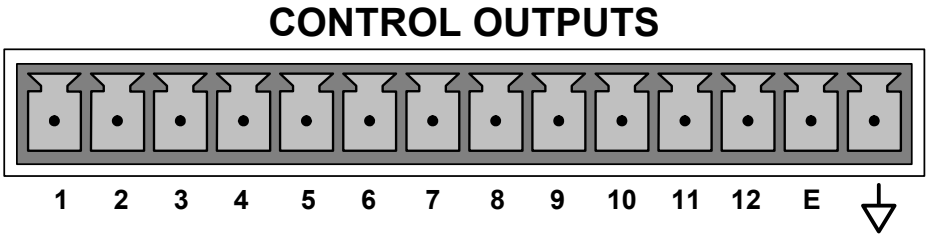


Figure 3-8: M703E Digital Control Output Connector

NOTE

Most PLC's have internal provisions for limiting the current the input will draw. When connecting to a unit that does not have this feature, external resistors must be used to limit the current through the individual transistor outputs to ≤50mA (120 Ω for 5V supply).

The pin assignments for the control outputs are:

Table 3-3: M703E Control Input Pin Assignments

PIN #	STATUS DEFINITION	CONDITION
1 - 12	Outputs 1 through 12 respectively	Closed if the sequence or sequence step activating output is operating
E	Emitter BUSS	The emitters of the transistors on pins 1 to 8 are bussed together.
⏚	Digital Ground	The ground level from the calibrator's internal DC power supplies.

3.2.6. CONNECTING THE SERIAL PORTS

If you wish to utilize either of the calibrator's two serial interface COMM ports, refer to Section 7.1 of this manual for instructions on their configuration and usage.

3.2.7. CONNECTING TO A LAN OR THE INTERNET

If your unit has a Teledyne Instruments Ethernet card (Option 63 and 64), plug one end into the 7' CAT5 cable supplied with the option into the appropriate place on the back of the calibrator and the other end into any nearby Ethernet access port.

NOTE:

The M703E firmware supports dynamic IP addressing or DHCP.

If your network also supports DHCP, the calibrator will automatically configure its LAN connection appropriately,

If your network does not support DHCP, see Section 7.5.2.1 for instructions on manually configuring the LAN connection.

3.2.8. CONNECTING TO A MULTIDROP NETWORK

If your unit has a Teledyne Instruments RS-232 multidrop card (Option 62), see Section 7.3 for instructions on setting it up.

3.3. PNENUMATIC CONNECTIONS

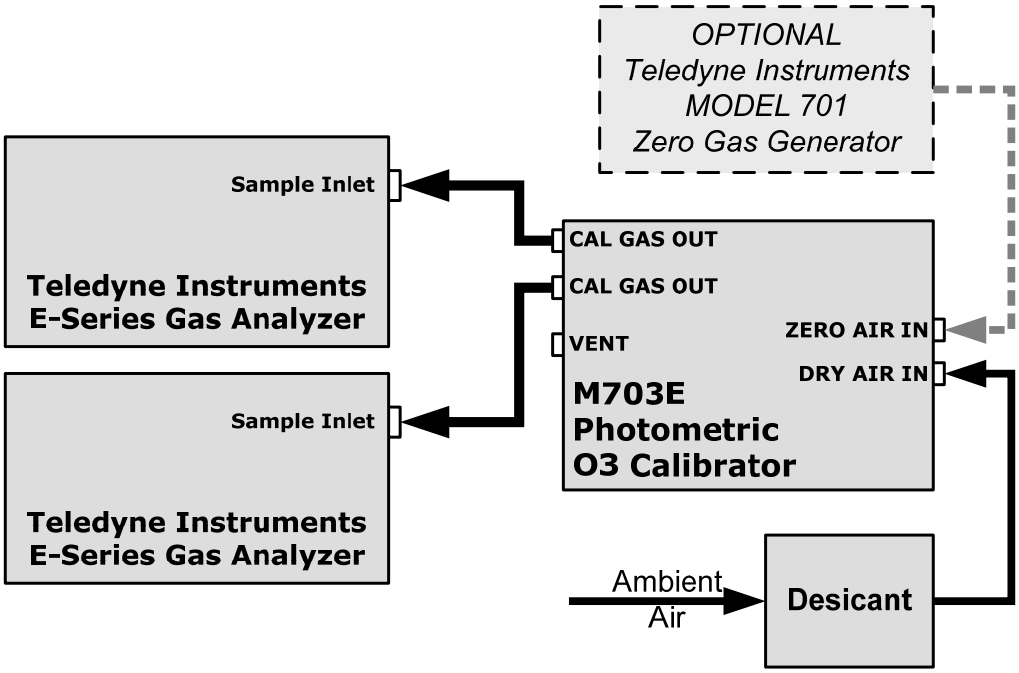


Figure 3-9: Basic Pneumatic Setup of M703E

3.3.1. DRY AIR IN

When using the internal zero air pump, a source of dry air should be connected to the port labeled 'Dry Air In' on the rear panel. This air should be supplied at atmospheric pressure. The supplied air should have a dew point of –20 °C or less.

Teledyne API can supply an optional desiccant cartridge that can be used to supply dry air to the M703E.

3.3.2. ZERO AIR IN

An external pressurized source of zero air can be supplied at the 'Zero Air" port on the rear panel. This is the standard configuration when the zero air pump is not installed. This zero air should be scrubbed of ozone and have a dew point of -20 °C or less. The pressure of the zero air should be regulated to 20-35 psig.

NOTE

When connecting an external source of zero air to an M703E with an internal zero air pump installed, the zero air pump should be disabled.

The "ZA_PUMP_ENABLE" VAR (see Section 6.10) should be set to OFF.

3.3.3. OUTPUT MANIFOLD

A four-port output manifold is supplied on the rear panel of the M703E enabling simultaneous testing of up to two external analyzers. Sample lines for ozone analyzers to be calibrated can be connected directly to this manifold.

To prevent ozone exposure, the bottom port of this manifold is used as a vent and should be connected to a proper unpressurized vent manifold. It is important that the backpressure at this vent fitting be kept to a minimum. If a vent line longer than 2 meters (~6 feet) is required, then 3/8" OD tubing should be used.

Any unused ports on this manifold must be capped.

3.3.4. EXHAUST

The port labeled 'EXHAUST' contains the exhaust gas from the internal photometer and may contain ozone. This port should be connected to a proper unpressurized vent manifold to prevent ozone exposure.

3.3.5. MEASURING AN EXTERNAL OZONE SOURCE

The M703E can easily be configured to measure an external source of ozone.

See Section 6.11 for details on operating the M703E in this manner.

USER NOTES

3.4. INITIAL OPERATION

If you are unfamiliar with the M703E theory of operation, we recommend that you read Chapter 9.

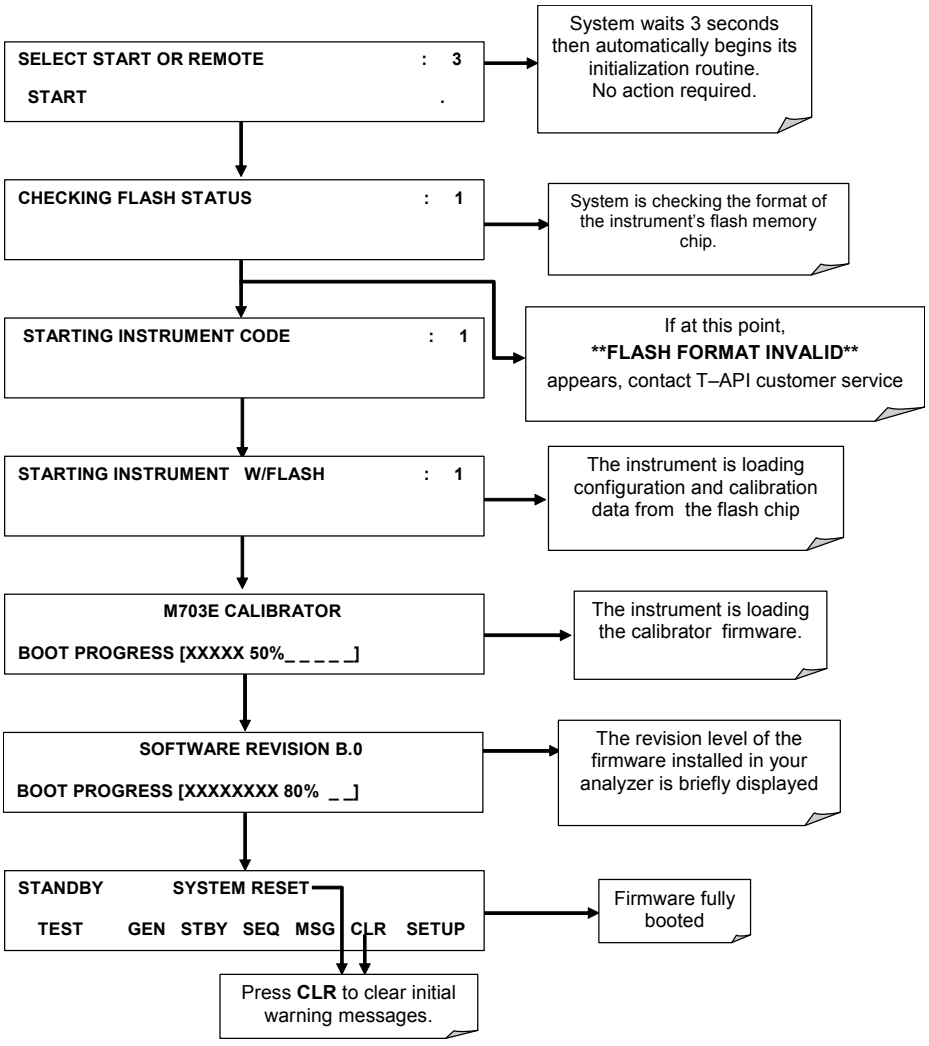
For information on navigating the calibrator's software menus, see the menu trees described in Appendix A.1.

3.4.1. START-UP

After all of the electrical and pneumatic connections are made, turn on the instrument. The exhaust fan and should start immediately. If the instrument is equipped with an internal photometer installed, the associated pump should also start up.

The display should immediately display a single, horizontal dash in the upper left corner of the display. This will last approximately 30 seconds while the CPU loads the operating system.

Once the CPU has completed this activity, it will begin loading the calibrator firmware and configuration data. During this process, string of messages will appear on the calibrator's front panel display:


SELECT START OR REMOTE : 3
START .
System waits 3 seconds then automatically begins its initialization routine. No action required.
CHECKING FLASH STATUS : 1
System is checking the format of the instrument's flash memory chip.
STARTING INSTRUMENT CODE : 1
If at this point, **FLASH FORMAT INVALID** appears, contact T–API customer service
STARTING INSTRUMENT W/FLASH : 1
The instrument is loading configuration and calibration data from the flash chip
M703E CALIBRATOR
BOOT PROGRESS [XXXXX 50%_ _ _ _ _]
The instrument is loading the calibrator firmware.
SOFTWARE REVISION B.0
BOOT PROGRESS [XXXXXXXX 80% _ _]
The revision level of the firmware installed in your analyzer is briefly displayed
STANDBY SYSTEM RESET
TEST GEN STBY SEQ MSG CLR SETUP
Firmware fully booted
Press CLR to clear initial warning messages.

The calibrator should automatically switch to **STANDBY** mode after completing the boot-up sequence.

3.4.2. WARM UP

The M703E Photometric calibrator requires a minimum of 30 minutes for all of its internal components to reach a stable operating temperature. During that time, various portions of the instrument's front panel will behave as follows. See Figure 3-1 for locations.

Table 3-4: Front Panel Display during System Warm-Up

Name	Color	Behavior	Significance
Main Message Field	N/A	Displays Warning messages and Test Function values	At initial start up the various warning messages will appear here (see Section 3.4.3 below).
Mode Field	N/A	Displays "STANDBY"	Instrument is in **STANDBY** mode.
STATUS LEDs			
Active	Green	OFF	Unit is operating in **STANDBY** mode. This LED glows green when the instrument is actively producing calibration gas.
Auto	Yellow	OFF	This LED only glows when the calibrator is performing an automatic calibration sequence.
Fault	Red	BLINKING	The calibrator is warming up and therefore many of its subsystems are not yet operating within their optimum ranges. Various warning messages will appear.

3.4.3. WARNING MESSAGES

Because internal temperatures and other conditions may be outside be specified limits during the calibrator's warm-up period, the software will suppress most warning conditions for 30 minutes after power up. If warning messages persist after the 30 minutes warm up period is over, investigate their cause using the troubleshooting guidelines in Chapter 11 of this manual.

To view and clear warning messages, press:

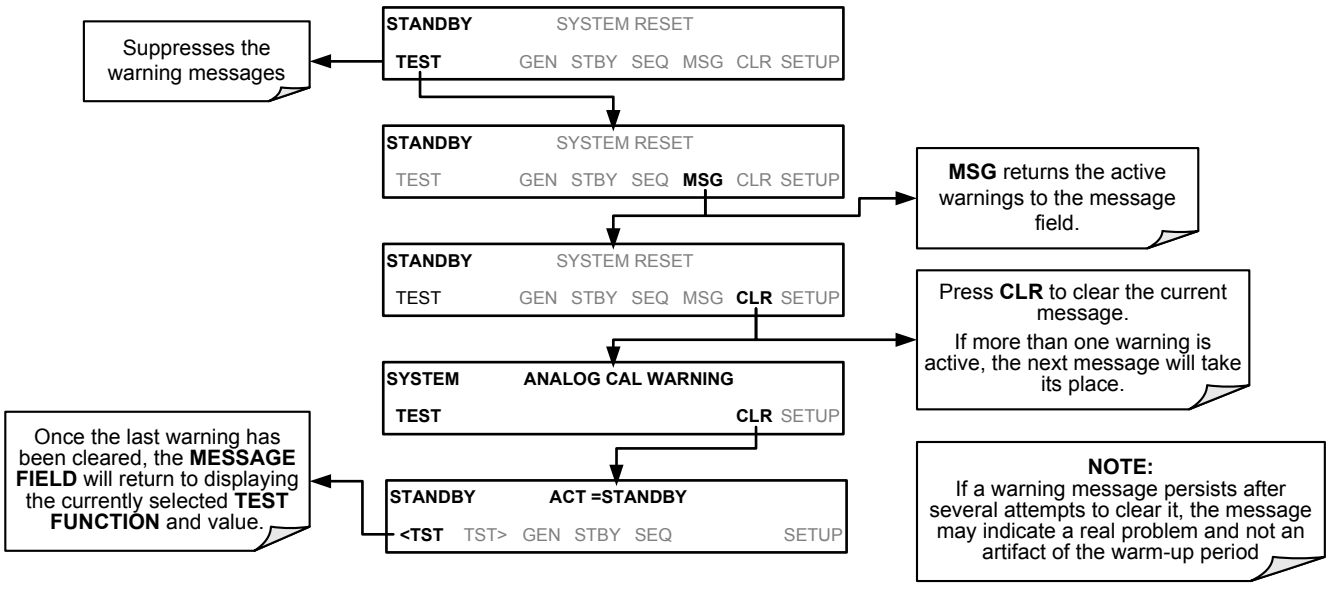

Suppresses the warning messages
STANDBY SYSTEM RESET
TEST GEN STBY SEQ MSG CLR SETUP
STANDBY SYSTEM RESET
TEST GEN STBY SEQ MSG CLR SETUP
MSG returns the active warnings to the message field.
STANDBY SYSTEM RESET
TEST GEN STBY SEQ MSG CLR SETUP
Press CLR to clear the current message.
If more than one warning is active, the next message will take its place.
SYSTEM ANALOG CAL WARNING
TEST CLR SETUP
Once the last warning has been cleared, the MESSAGE FIELD will return to displaying the currently selected TEST FUNCTION and value.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
NOTE:
If a warning message persists after several attempts to clear it, the message may indicate a real problem and not an artifact of the warm-up period

Table 3-5 lists brief descriptions of the warning messages that may occur during start up.

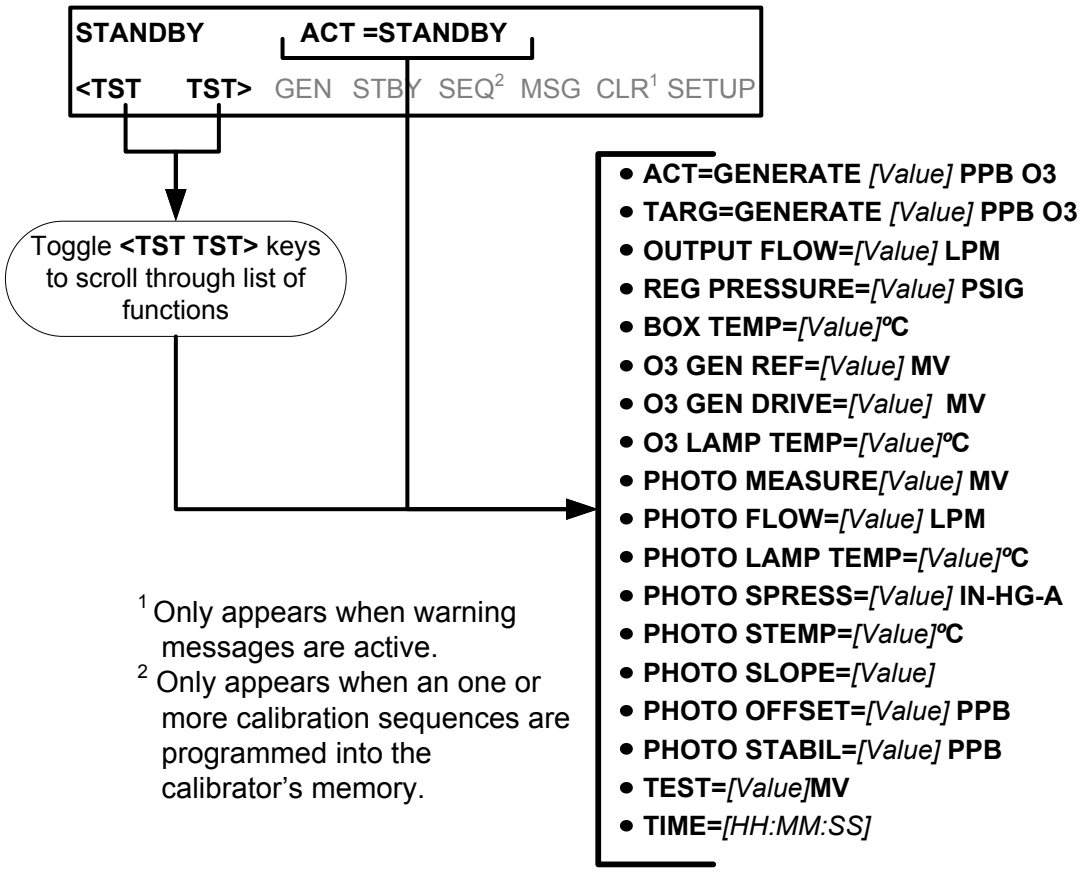
Table 3-5: Possible Warning Messages at Start-Up

MESSAGE	MEANING
ANALOG CAL WARNING	The calibrator's A/D converter or at least one analog input channel has not been calibrated.
CONFIG INITIALIZED	Stored Configuration information has been reset to the factory settings or has been erased.
DATA INITIALIZED	The calibrator's data storage was erased.
FRONT PANEL WARN	The firmware is unable to communicate with the front panel.
LAMP DRIVER WARN	The firmware is unable to communicate with either the O_3 generator or photometer lamp I^2C driver chips.
O3 GEN LAMP TEMP WARNING	The O_3 generator lamp temperature is outside of allowable limits.
O3 GEN REFERENCE WARNING	The O_3 generator's reference detector has dropped below the minimum allowable limit.
O3 PUMP WARNING	The pump associated with the O_3 photometer has failed to turn on.
PHOTO LAMP TEMP WARNING	The photometer lamp temperature is outside of allowable limits.
PHOTO REFERENCE WARNING	The photometer reference reading is outside of allowable limits.
REAR BOARD NOT DET	The calibrator's motherboard was not detected during power up.
RELAY BOARD WARN	The firmware is unable to communicate with the calibrator's relay board.
SYSTEM RESET	The calibrator has been turned off and on or the CPU was reset.

3.4.4. FUNCTIONAL CHECK

7. After the calibrator's components have warmed up for at least 30 minutes, verify that the software properly supports any hardware options that are installed.
8. Check to make sure that the calibrator is functioning within allowable operating parameters. Appendix C includes a list of test functions viewable from the calibrator's front panel as well as their expected values. These functions are also useful tools for diagnosing problems with your calibrator (see Section7.5.2). The enclosed Final Test and Validation Data sheet (part number 05760) lists these values before the instrument left the factory.

   To view the current values of these parameters press the following key sequence on the calibrator's front panel. Remember until the unit has completed its warm up these parameters may not have stabilized.


STANDBY
ACT =STANDBY
<TST TST> GEN STBY SEQ[2] MSG CLR[1] SETUP
Toggle <TST TST> keys to scroll through list of functions
• ACT=GENERATE [Value] PPB O3
• TARG=GENERATE [Value] PPB O3
• OUTPUT FLOW=[Value] LPM
• REG PRESSURE=[Value] PSIG
• BOX TEMP=[Value]ºC
• O3 GEN REF=[Value] MV
• O3 GEN DRIVE=[Value] MV
• O3 LAMP TEMP=[Value]ºC
• PHOTO MEASURE[Value] MV
• PHOTO FLOW=[Value] LPM
• PHOTO LAMP TEMP=[Value]ºC
• PHOTO SPRESS=[Value] IN-HG-A
• PHOTO STEMP=[Value]ºC
• PHOTO SLOPE=[Value]
• PHOTO OFFSET=[Value] PPB
• PHOTO STABIL=[Value] PPB
• TEST=[Value]MV
• TIME=[HH:MM:SS]
[1] Only appears when warning messages are active.
[2] Only appears when an one or more calibration sequences are programmed into the calibrator's memory.

9. If your calibrator has an Ethernet card (Option 63) installed and your network is running a dynamic host configuration protocol (DHCP) software package, the Ethernet option will automatically configure its interface with your LAN. However, it is a good idea to check these settings to make sure that the DHCP has successfully downloaded the appropriate network settings from your network server (See Section 7.5.2).

   If your network is not running DHCP, you will have to configure the calibrator's interface manually (See Section 7.5.2.

3.4.5. OPERATING MODES FOR THE O_3 GENERATOR

The O_3 generator can be set to operate in three different modes:

3.4.5.1. CNST (CONSTANT)

In this mode, the O_3 output of the generator is based on a single, constant, drive voltage. There is no Feedback loop control by the M703E's CPU in this mode.

3.4.5.2. REF (REFERENCE)

The O_3 control loop will use the reference detector's measurement of the O_3 generator's UV lamp as input. This mode does not use the photometer to control the ozone generator.

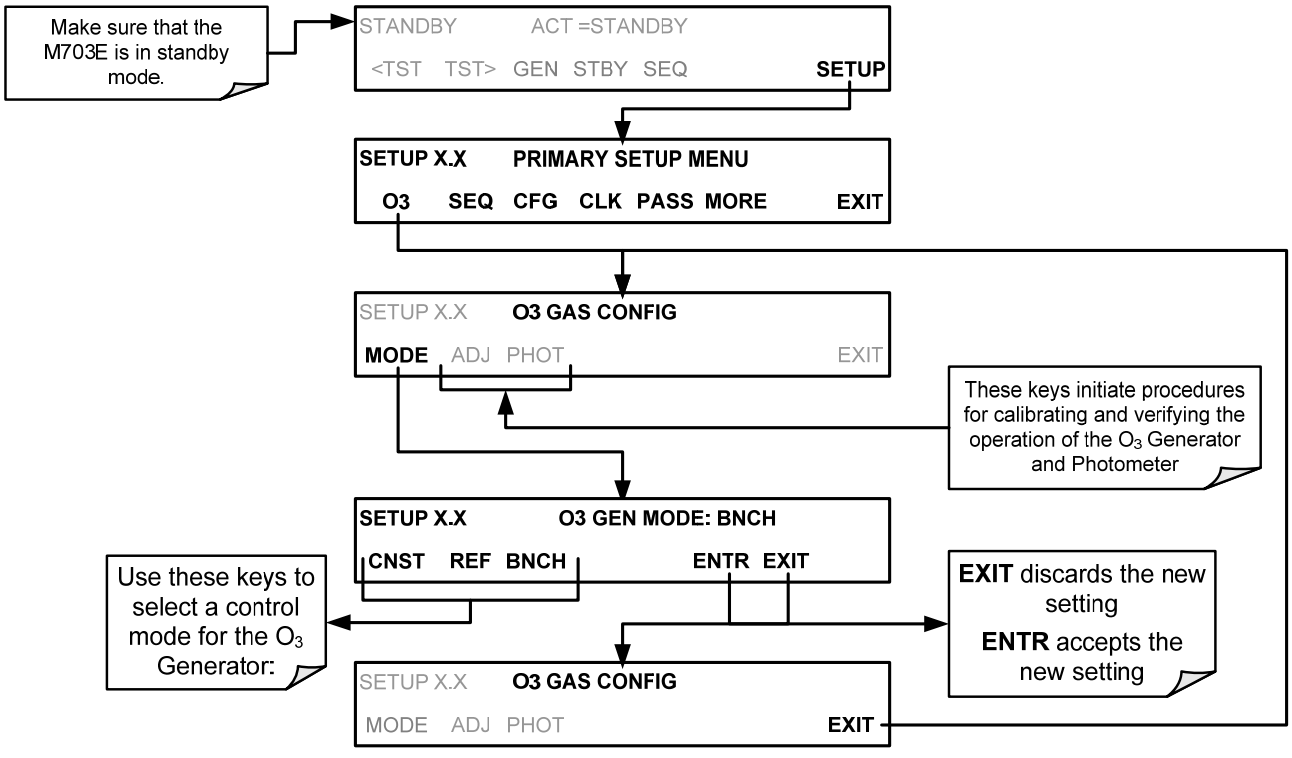
3.4.5.3. BNCH (BENCH)

The O_3 concentration control loop will use the photometer's O_3 measurement as input.
THIS IS THE DEFAULT AND MOST COMMON MODE OF OPERATION.

This setting will be the default mode of the M703E calibrator and will be mused whenever the calibrator is using the GENERATE → **AUTO** command or the **GENERATE** sequence step to create a calibration mixture. When either the **GENERATE → MAN** command or the **MANUAL** sequence step is active, the local O_3 generator mode (chosen during when the command/step is programmed) will take precedence.

3.4.6. SETTING THE O3 GENERATOR MODE

To select a default O_3 generator mode, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X O3 GAS CONFIG
MODE ADJ PHOT EXIT
These keys initiate procedures for calibrating and verifying the operation of the O3 Generator and Photometer
SETUP X.X O3 GEN MODE: BNCH
CNST REF BNCH ENTR EXIT
Use these keys to select a control mode for the O3 Generator:
EXIT discards the new setting
ENTR accepts the new setting
SETUP X.X O3 GAS CONFIG
MODE ADJ PHOT EXIT

3.4.7. SETTING THE M703E'S OUTPUT FLOW RATE

The output flow rate of the M703E should be adjusted to match the gas flow requirements of the analyzers connected to the output manifold.

NOTE

- **The minimum total flow should equal the sum of the flow requirements of all of the instruments to which the M703E will be supplying calibration gas plus 1 LPM excess flow.**
- **Example: If the M703E is will be expected to supply calibration gas mixtures simultaneously to two analyzers each requiring 0.8 LPM , the proper Total Flow output should be set at a minimum of: (0.8 + 0.8) + 1.0= 2.6 LPM**

To set the output flow:

1. Open the front panel of the calibrator down by releasing the two snap-in fasteners at the top of the front panel.
2. Pull out the regulator knob and adjust the regulator until the desired flow is achieved.
   - The front panel of the M703E displays the approximate output flow based on the measured regulator pressure, but this flow should be verified with an independent calibrated flow meter attached to the on of the CAL GAS outlets on the back of the instrument (see Figure 3-2).
3. Push the regulator knob back in to lock.
4. Close the front panel.

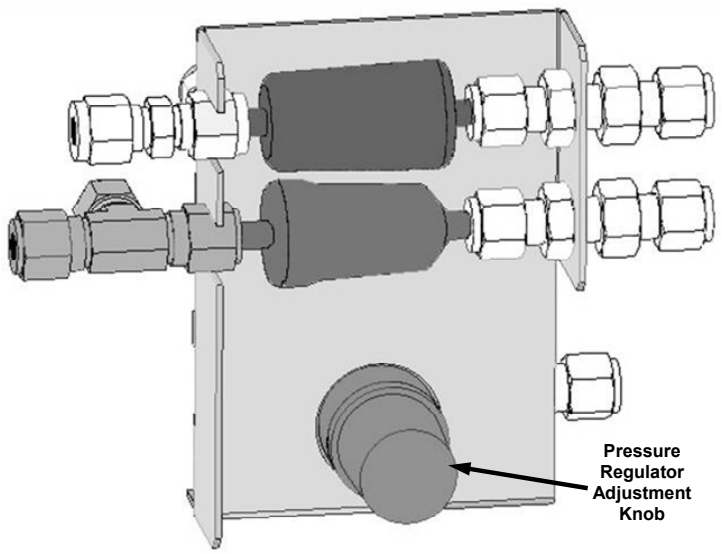


Figure 3-10: Location of Pressure Regulator Adjustment Knob

USER NOTES:

4. FREQUENTLY ASKED QUESTIONS AND GLOSSARY

4.1. FAQ'S

The following list is a list from the T-API Customer Service Department of the 10 most commonly asked questions relating to the Model 703E Photometric Calibrator.

Q: My ozone ACT =XXXX, why?

A: Look at the Photo Ref/Meas readings from the photometer UV lamp detector are most likely too low and need to be adjusted. See Section 10.5

Q: When I generate ozone, it takes a long time to settle out or it fluctuates around the target concentration until finally stabilizing.

A: Perform an O3 Gen Calibration. See Section 8.2.

Q: Why does the **ENTR** key sometimes disappear on the front panel display?

A: Sometimes the **ENTR** key will disappear if you select a setting that is invalid or out of the allowable range for that parameter, such as trying to set the 24-hour clock to 25:00:00.

Once you adjust the setting to an allowable value, the **ENTR** key will re-appear.

Q: How do I make the RS-232 Interface Work?

A: See Chapter 7

Q: When should I change the sintered filter(s) in the calibrators flow control(s) and how do I change them?

A: The sintered filters do not require regular replacement. Should one require replacement as part of a troubleshooting or repair exercise, see Section 11.8.1.

Q: How often should I rebuild the photometer pump on my calibrator?

A: The photometer pump has been designed for longer service life than standard diaphragm pumps. When the pump wears out, the entire pump must be replaced.

Q: How long do the UV lamps of the O_3 generator and photometer last?

A: The typical lifetime is about 2-3 years.

4.2. GLOSSARY

Acronym – A short form or abbreviation for a longer term. Often artificially made up of the first letters of the phrase's words.

APICOM – Name of a remote control program offered by Teledyne-API to its customers

ASSY - Acronym for *Assembly.*

cm^{3-} metric abbreviation for *cubic centimeter*. Same as the obsolete abbreviation "cc".

DIAG - Acronym for *diagnostics*, the diagnostic menu or settings of the system

DHCP: acronym for *dynamic host configuration protocol.* A protocol used by LAN or Internet servers that automatically sets up the interface protocols between themselves and any other addressable device connected to the network.

DOC – Acronym for *Disk On Chip*, the system's central storage area for system operating system, firmware and data. This is a solid-state device without mechanical, moving parts that acts as a computer hard disk drive under DOS with disk drive label "C". DOC chips come with 8 mb space in the E-series system standard configuration but are available in larger sizes

DOS - *Disk Operating System*. The E-series systems use DR DOS

EEPROM - also referred to as a FLASH chip.

FEP - Acronym for Fluorinated Ethylene Propylene polymer, one of the polymers that *du Pont* markets as *Teflon*® (along with PFA and PTFE).

FLASH - flash memory is non-volatile, solid-state memory.

I^2C bus – read: I-square-C bus. A serial, clocked serial bus for communication between individual system components

IC – Acronym for *Integrated Circuit*, a modern, semi-conductor circuit that can contain many basic components such as resistors, transistors, capacitors etc in a miniaturized package used in electronic assemblies.

iDAS - Acronym for *Internal Data Acquisition System*, previously referred to as DAS.

LAN - Acronym for *local area network.*

LED - Acronym for *Light Emitting Diode.*

LPM – Acronym for liters per minute

MFC – Acronym for "mass flow controller".

MOLAR MASS – The molar mass is the mass, expressed in grams, of one mole of a specific substance. Conversely, one mole is the amount of the substance needed for the molar mass to be the same number in grams as the atomic mass of that substance.

> EXAMPLE: The atomic weight of Carbon is 12 therefore the molar mass of Carbon is 12 grams, conversely, one mole of carbon equals the amount of carbon atoms that weighs 12 grams.

Atomic weights can be found on any Periodic Table of Elements

PCA - Acronym for *Printed Circuit Assembly*, this is the → PCB with electronic components installed and ready to use

PCB - Acronym for *printed circuit board*, the bare circuit board without components

PLC – Acronym for *programmable logic controller*, a device that is used to control instruments based on a logic level signal coming from the system

PFA – Acronym for Per-Fluoro-Alkoxy, an inert polymer. One of the polymers that *du Pont* markets as *Teflon*® (along with FEP and PTFE).

PTFE – Acronym for Poly-Tetra-Fluoro-Ethylene, a very inert polymer material used to handle gases that may react on other surfaces. One of the polymers that *du Pont* markets as *Teflon*® (along with FEP and PFA).

PVC – Acronym for *Poly Vinyl Chloride*.

RS-232 - An electronic communication protocol of a serial communications port

RS-485 - An electronic communication protocol of a serial communications port

SLPM – Acronym for standard liters per minute; liters per minute of a gas at standard temperature and pressure

TCP/IP - Acronym for *Transfer Control Protocol / Internet Protocol*, the standard communications protocol for Ethernet devices and the Internet

VARS - Acronym for *variables*, the variables menu or settings of the system

USER NOTES:

5. OPTIONAL HARDWARE AND SOFTWARE

This includes a brief description of the hardware and software options available for the M703E Photometric Calibrator. For assistance with ordering these options, please contact the Sales department of Teledyne – Advanced Pollution Instruments at:

TOLL-FREE: 800-324-5190
FAX: 858-657-9816
TEL: 858-657-9800
E-MAIL: api-sales@teledyne.com
WEB SITE: www.teledyne-api.com

5.1. CARRYING STRAP HANDLE (OPT 29)

The chassis of the M703E calibrator allows to attach a strap handle for carrying the instrument (Figure 5-). The handle is located on the right side and pulls out to accommodate a hand for transport. When pushed in, the handle is nearly flush with the chassis, only protruding out about 9 mm (3/8").

Figure 5-1: M703E with Carrying Strap Handle and Rack Mount Brackets

Installing the strap handle prevents the use of the rack mount slides, although the rack mount brackets, Option 21, can still be used.

	CAUTION **A FULLY LOADED M703E WITH BOTH THE O_3 GENERATOR AND PHOTOMETER OPTIONS INSTALLED WEIGHS ABOUT 16.3 KG (36 POUNDS).** **TO AVOID PERSONAL INJURY WE RECOMMEND TWO PERSONS LIFT AND CARRY THE CALIBRATOR.** **MAKE SURE TO DISCONNECT ALL CABLES AND TUBING FROM THE CALIBRATOR BEFORE CARRYING IT.**

5.2. COMMUNICATION OPTIONS

5.2.1. RS232 MODEM CABLES (OPTS 60 AND 60A)

The analyzer can have come standard with a shielded, straight-through DB-9F to DB-9F cable of about 1.8 m length, which should fit most computers of recent build. This cable can be ordered as Option 60.

Option 60A consists of a shielded, straight-through serial cable of about 1.8 m length to connect the calibrator's COM1 port to a computer, a code activated switch or any other communications device that is equipped with a DB-25 female connector. The cable is terminated with one DB-9 female connector and one DB-25 male connector. The DB-9 connector fits the calibrator's RS-232 port.

5.2.2. ETHERNET CABLE (OPT 60B)

Option 60B consists of a 7-foot long, CAT-5 network cable, terminated at both ends with standard RJ-45 connectors. This cable is used to connect the M703E to any standard ETHERNET socket.

5.2.3. RS-232 MULTIDROP (OPT 62)

The multidrop option is used with any of the RS-232 serial ports to enable communications of up to eight calibrators with the host computer over a chain of RS-232 cables via the instruments COM1 Port. It is subject to the distance limitations of the RS 232 standard.

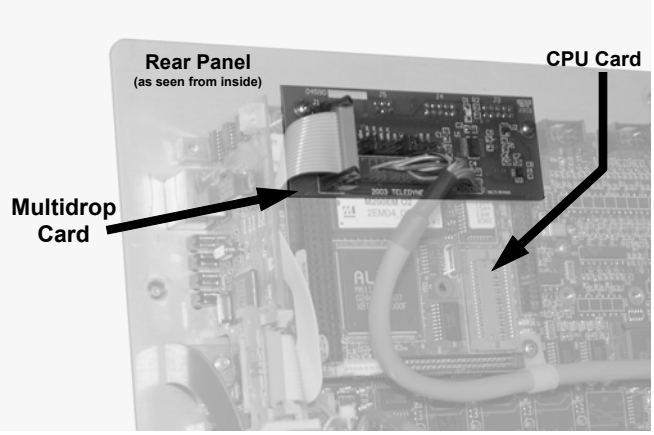


Figure 5-1: M703E Multidrop Card

The option consists of a small printed circuit assembly, which plugs into to the calibrator's CPU card (see Figure 5-6). It is connected to the RS-232 and COM2 DB9 connectors on the instrument's back panel via a cable to the motherboard. One option 62 is required for each calibrator along with one 6' straight-through, DB9 male → DB9 Female cable (P/N WR0000101).

5.2.4. ETHERNET (OPT 63)

The ETHERNET option allows the calibrator to be connected to any Ethernet local area network (LAN) running TCP/IP. The local area network must have routers capable of operating at 10BaseT. If Internet access is available through the LAN, this option also allows communication with the instrument over the public Internet. Maximum communication speed is limited by the RS-232 port to 115.2 kBaud.

When installed, this option is electronically connected to the instrument's COM2 serial port making that port no longer available for RS-232/RS-485 communications.

The option consists of a Teledyne Instruments designed Ethernet card (see Figures 5-7 and 5-8), and a 7-foot long CAT-5 network cable, terminated at both ends with standard RJ-45 connectors.

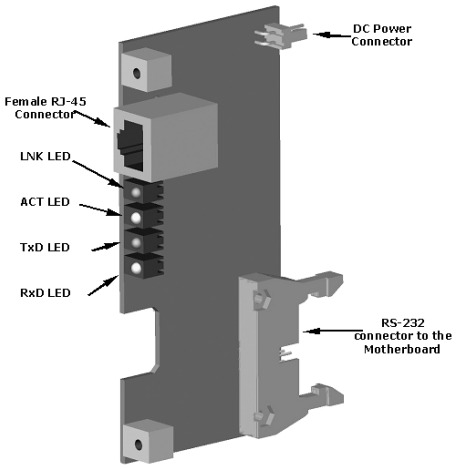


Figure 5-2: M703E Ethernet Card

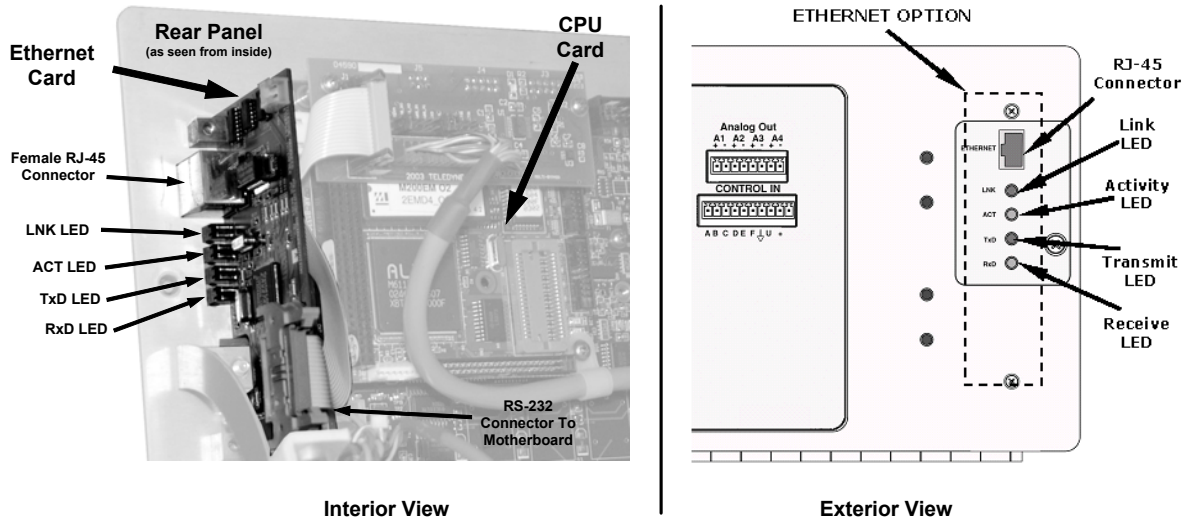


Figure 5-3: M703E Rear Panel with Ethernet Installed

For more information on setting up and using this option, see Section7.5

5.2.5. ETHERNET + MULTIDROP (OPT 64)

This option allows the instrument to communicate on both RS-232 and ETHERNET networks simultaneously. It includes the following:

- RS232 MODEM CABLES (OPT 60A)
- ETHERNET CABLE (OPT 60B)
- RS-232 MULTIDROP (OPT 62)
- ETHERNET (OPT 63

5.3. ADDITIONAL MANUAL (OPT 70)

Additional copies of the printed user's manual can be purchased from the factory. Please specify the serial number of your calibrator so that we can match the manual version.

This operator's manual is also available on CD. The electronic document is stored in Adobe Systems Inc. *Portable Document Format* (PDF) and is viewable with Adobe Acrobat Reader® software, which can be downloaded for free at http://www.adobe.com/

The electronic version of this manual can also be downloaded free at http://www.teledyne-api.com/manuals/. Note that the online version is optimized for fast download and may not print with the same quality as the manual on CD.

5.4. EXTENDED WARRANTY (OPT 92)

An extended, two-year warranty is available for the M703E calibrator. This option must be specified upon ordering the calibrator.

5.5. NIST TRACEABLE, PRIMARY STANDARD CERTIFICATION

The Model 703E can be used as a Primary Ozone Standard. For this application the performance of the M703E Photometric Calibrator calibrated to Standard Reference Photometer (SRP)

Calibrators ordered with this option are verified and validated in accordance with the procedures prescribed by the U.S. Environmental Protection Agency (EPA) under Title 40 of the Code of Federal Regulations, Part 50, Appendix D (40 CFR Part 50).

An NIST traceable Certificate of Calibration and accompanies the instrument.

USER NOTES:

SECTION II
–
OPERATING INSTRUCTIONS

USER NOTES:

6. OPERATING THE M703E CALIBRATOR

The M703E calibrator is a computer-controlled calibrator with a dynamic menu interface for easy and yet powerful and flexible operation. All major operations are controlled from the front panel display and keyboard through these user-friendly menus.

To assist in navigating the system's software, a series of menu trees can be found in Appendix A of this manual.

NOTE

The flowcharts in this chapter depict the manner in which the front panel display/keyboard interface is used to operate the M703E Photometric Calibrator.

They depict typical representations of the display during the various operations being described.

They are not intended to be exact and may differ slightly from the actual display of your system.

NOTE

When editing values in the software, the ENTR key may disappear if you select a value that is invalid or out of the allowable range for that parameter (e.g. such as trying to set the 24-hour clock to 25:00:00). Once you adjust the setting to an allowable value, the ENTR key will re-appear.

6.1. TEST FUNCTIONS

A variety of **TEST FUNCTIONS** are available for viewing at the front panel whenever the calibrator is at the **MAIN MENU**. These measurements provide information about the present operating status of the calibrator and are useful during troubleshooting (see Chapter 11). Table 6-1 lists the available **TEST** functions.

To view these **TEST** functions, press **<TST** or **TST>** from the main menu and the **Test Functions** will scroll at the top center of the display.

Table 6-1: Test Functions Defined

TEST MEASUREMENT	DESCRIPTION
ACT=GENERATE XX PPB O3	Actual concentration being generated, computed from real-time inputs.
TARG=GENERATE XX PPB O3	Target concentration to generate.
OUTPUT FLOW=X.XXX LPM	Output flow rate (computed from regulator pressure).
REG PRESSURE=XX.X PSIG	Regulator pressure.
BOX TEMP=XX.X ºC	Internal chassis temperature.
O3 GEN REF=XXXX.X MV	O_3 generator reference detector reading.
O3 GEN DRIVE=XXXX.X MV	O_3 generator lamp drive output.
O3 LAMP TEMP=XX.X ºC	O_3 generator lamp temperature.
PHOTO MEASURE=XXXX.X MV	Photometer detector measure reading.
PHOTO REFERENCE=XXXX.X MV	Photometer detector reference reading.
PHOTO FLOW=X.XXX LPM	Photometer sample flow rate.
PHOTO LAMP TEMP=XX.X ºC	Photometer lamp temperature.
PHOTO SPRESS=XX.X IN-HG-A	Photometer sample pressure.
PHOTO STEMP=XX.X ºC	Photometer sample temperature.
PHOTO SLOPE=X.XXX	Photometer slope computed during zero/span bench calibration.
PHOTO OFFSET=X.X PPB	Photometer offset computed during zero/span bench calibration.
PHOTO STABIL=X.X PPB	Photometer concentration stability (standard deviation of 25 bench concentration samples taken 10 seconds apart).
TEST=XXXX.X MV	Value output to *TEST_OUTPUT* analog output, selected with *TEST_CHAN_ID* variable.
TIME=HH:MM:SS	Current instrument time of day clock. (24 hour format)

6.2. OVERVIEW OF OPERATING MODES

The M703E calibrator software has a variety of operating modes. Most commonly, the calibrator will be operating in **STANDBY** mode. In this mode, the calibrator and all of its subsystems are inactive although **TEST** functions and **WARNING** messages are still updated can be examined via the front panel.

The second most important operating mode is **SETUP** mode. This mode is used for performing certain configuration operations, such as programming the concentration of source gases, setting up automatic calibration sequences and configuring the analog / digital inputs and outputs. The **SET UP** mode is also used for accessing various diagnostic tests and functions during troubleshooting.

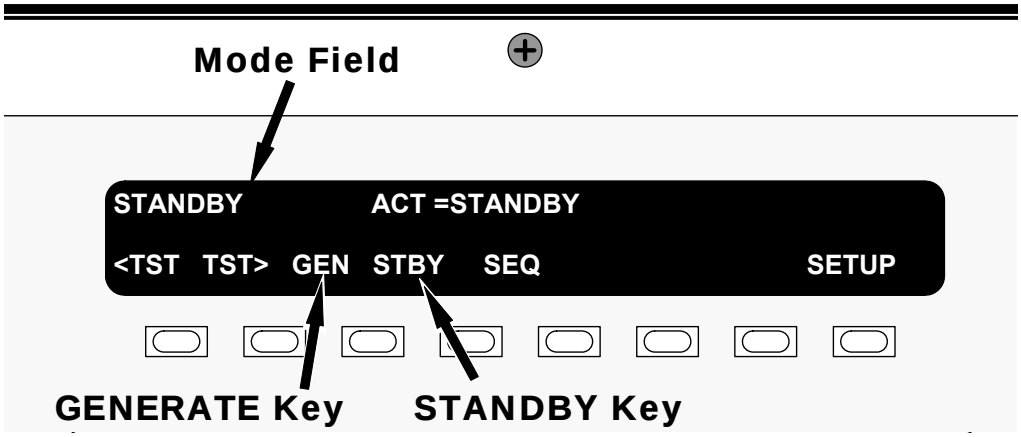


Figure 6-1: Front Panel Display

The mode field of the front panel display indicates to the user which operating mode the unit is currently running.

Besides **STANDBY** and **SETUP**, other modes the calibrator can be operated in are:

Table 6-2: Calibrator Operating Modes

MODE	MEANING
DIAG	One of the calibrator's diagnostic modes is being utilized. When those diagnostic functions that have the greatest potential to conflict with generating concentrations are active, the instrument is automatically placed into standby mode.
GENERATE	In this mode, the instrument is engaged in producing calibration gas.
SETUP[3]	**SETUP** mode is being used to configure the calibrator.
STANDBY	The calibrator is not actively generating gas.
[3] The revision of the Teledyne Instruments software installed in this calibrator will be displayed following the word **SETUP**. E.g. "**SETUP B.4**"	

6.3. STANDBY MODE

When the M703E Photometric Calibrator is in standby mode, it is at rest.

- Some functions under the **SETUP → MORE → DIAG** submenu, those which conflict with accurate creation of calibration gas mixtures (e.g. **ANALOG OUTPUT STEP TEST**) automatically place the calibrator into **STANDBY** mode when activated

NOTE

The M703E calibrator should always be placed in STANDBY mode when not needed to produce calibration gas.

This can be done manually by pressing the STBY button that appears when the calibrator's display is showing the top-level menu (see Figure 6-1).

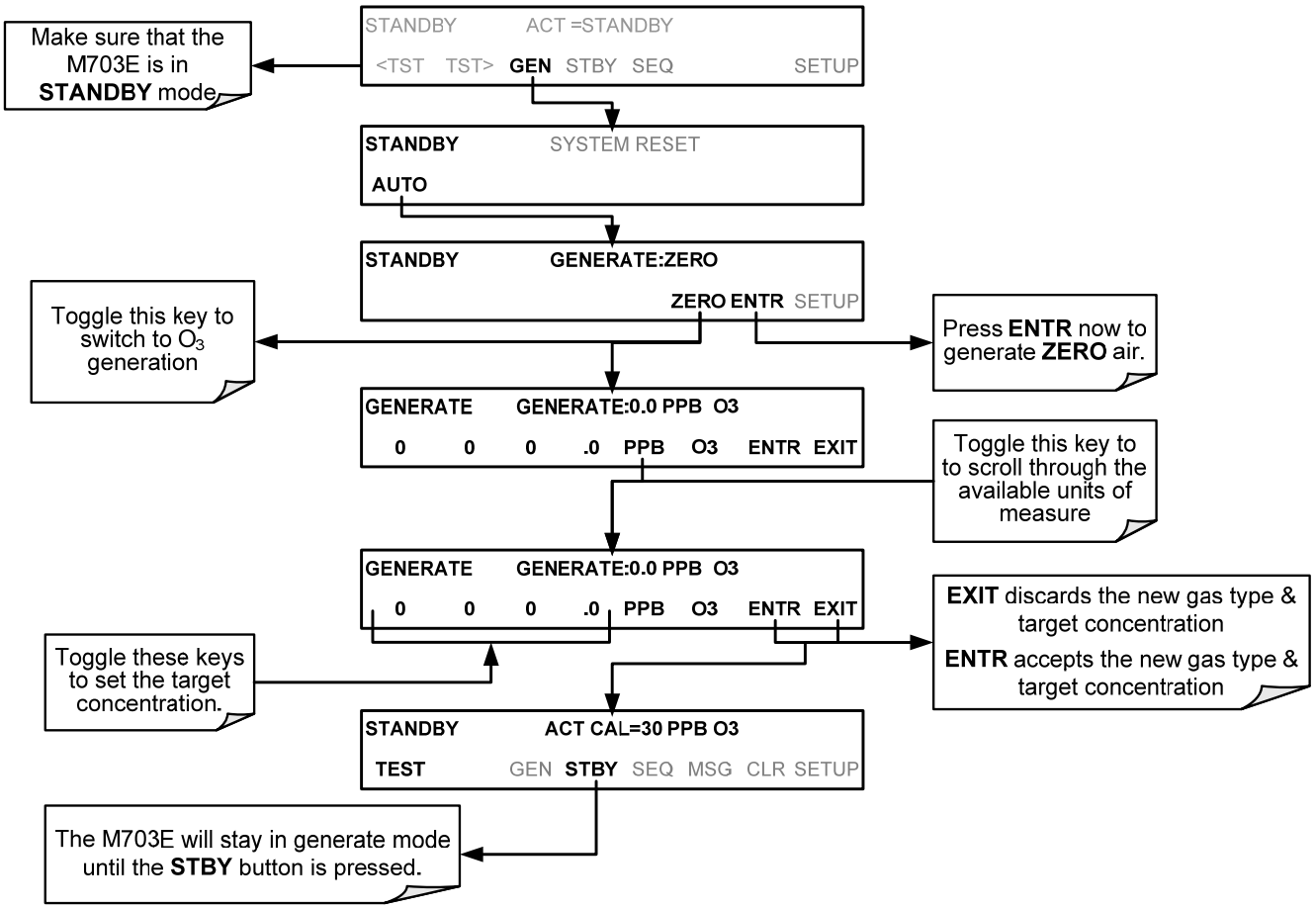
When programming a calibration sequences the STANDBY step should always be inserted at the end of the sequence.

6.4. GENERAL INFORMATION ABOUT THE GENERATE MODE

The GENERATE mode is the mode of operation where the M703E is actively producing calibration gas, either zero or some specified concentration of ozone. In the **GENERATE** mode the Zero Air Pump (if enabled) and Photometer Pump are turned on.

6.4.1. GENERATE → AUTO: Basic Generation of Calibration Gas

This is the simplest procedure for generating calibration gas mixtures. To generate calibration gas, press


Make sure that the M703E is in **STANDBY** mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
STANDBY SYSTEM RESET
AUTO
STANDBY GENERATE:ZERO
ZERO ENTR SETUP
Toggle this key to switch to O_3 generation
Press **ENTR** now to generate **ZERO** air.
GENERATE GENERATE:0.0 PPB O3
0 0 0 .0 PPB O3 ENTR EXIT
Toggle this key to to scroll through the available units of measure
GENERATE GENERATE:0.0 PPB O3
0 0 0 .0 PPB O3 ENTR EXIT
EXIT discards the new gas type & target concentration
ENTR accepts the new gas type & target concentration
Toggle these keys to set the target concentration.
STANDBY ACT CAL=30 PPB O3
TEST GEN STBY SEQ MSG CLR SETUP
The M703E will stay in generate mode until the **STBY** button is pressed.

The M703E will now enter **GENERATE** mode.

6.5. AUTOMATIC CALIBRATION SEQUENCES

The M703E calibrator can be set up to perform automatic calibration sequences of multiple steps. These sequences can perform all of the calibration operations available for manual operation and can be set up to be triggered by using the front panel buttons, the M703E's internal timer, the external digital control inputs, the RS-232 interface, via the optional Ethernet interface or even as sub-processes in another sequence.

6.5.1. SETUP → SEQ: PROGRAMMING CALIBRATION SEQUENCES

A sequence is a database of single or multiple steps where each single step is an instruction that causes the instrument to perform an operation. These steps are grouped under a user defined SEQUENCE **NAME**.

For each sequence, seven attributes must be programmed. They are:

Table 6-3: Automatic Calibration SEQUENCE Set Up Attributes

ATTRIBUTE NAME	DESCRIPTION
NAME	Allows the user to create a text string of up to 10 characters identifying the sequence.
REPEAT COUNT	Number of times, between 0 and 100, to execute the same sequence. A value of 0 (zero) causes the sequence to execute indefinitely.
CC INPUT	Specifies which of the M703E's Digital Control Inputs will initiate the sequence.
CC OUTPUT	Specifies which of the M703E's Digital Control Outputs will be set when the sequence is active.
TIMER ENABLE	Enables or disables an internal automatic timer that can initiate sequences using the M703E's built in clock.
STEPS	A series of submenus for programming the activities and instructions that make up the calibration sequence.
PROGRESS MODE	Allows the user to select the reporting style the calibrator uses to report the progress of the sequences , on the front panels display, as it runs

The types of instruction steps available for creating calibration sequences are:

Table 6-4: Calibration SEQUENCE Step Instruction

INSTRUCTION NAME	DESCRIPTION
GENERATE	Puts the instrument into **GENERATE** mode. Similar in operation and effect to the **GENERATE** → **AUTO** function used at the front panel.
DURATION	Adds a period of time between the previous instruction and the next
EXECSEQ	Calls another sequence to be executed at this time. The calling sequence will resume running when the called sequence is completed. Up to 5 levels of nested sequences can be programmed.
SETCCOUTPUT	Allows the sequence to activate the M703E's digital control outputs. Similar to the CC OUPUT attribute, but can be set and reset by individual steps.

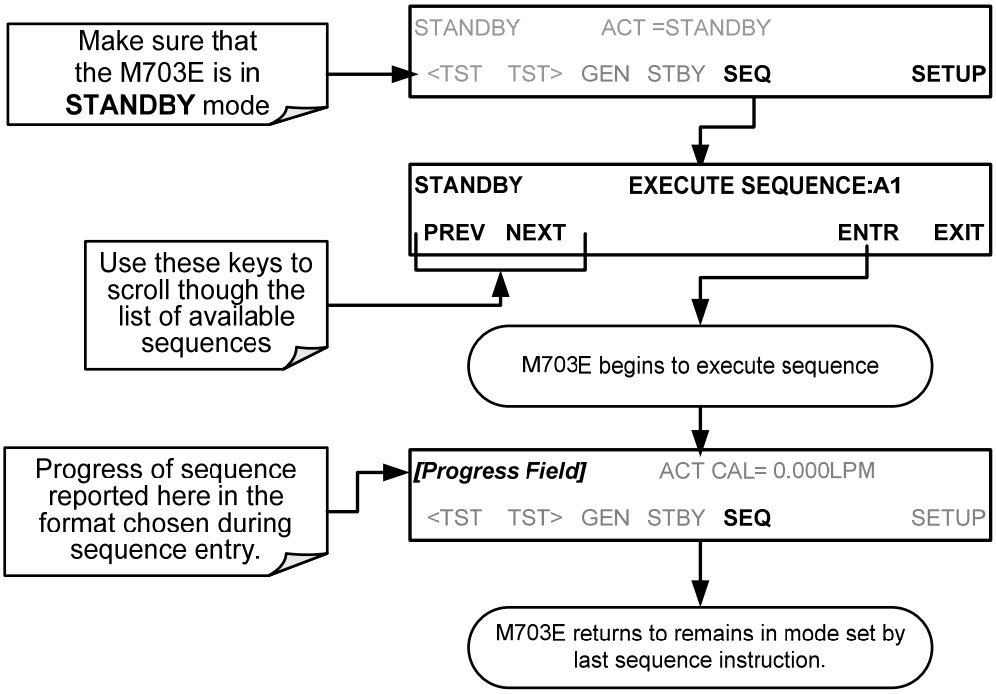
NOTE

It is generally a good idea to end each calibration sequence with an instruction to return the instrument to STANDBY mode.

To create a sequence, use the instructions in the following sections to name the sequence, set it associated parameters and define the steps to be included.

6.5.1.1. Activating a Sequence from the M703E Front Panel

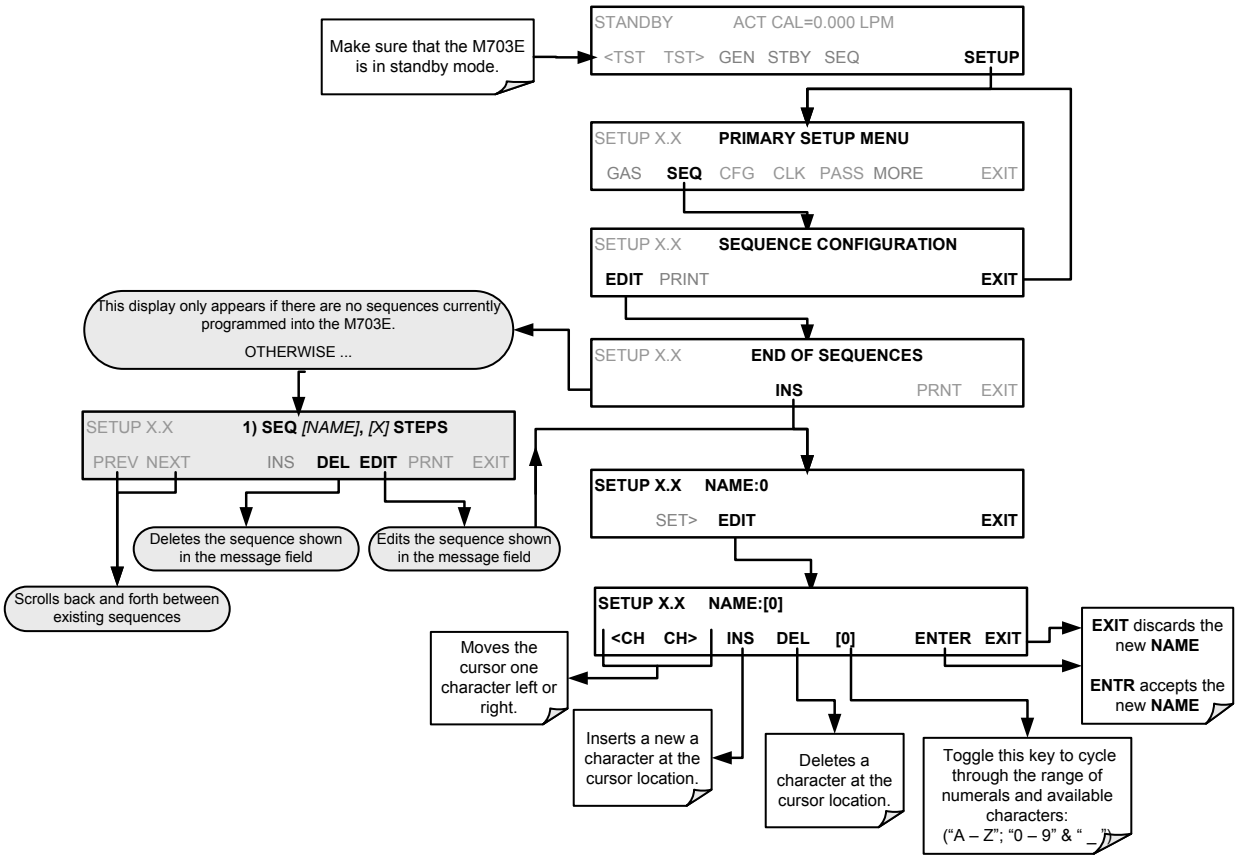
To activate an already programmed sequence from the front panel, press:


Make sure that the M703E is in **STANDBY** mode
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
STANDBY EXECUTE SEQUENCE:A1
PREV NEXT ENTR EXIT
Use these keys to scroll though the list of available sequences
M703E begins to execute sequence
Progress of sequence reported here in the format chosen during sequence entry.
[Progress Field] ACT CAL= 0.000LPM
<TST TST> GEN STBY SEQ SETUP
M703E returns to remains in mode set by last sequence instruction.

6.5.1.2. Naming a Sequence

The first step of creating a calibration sequence is to assign it a name. The name can be up to 10 characters and can be comprised of any alpha character (A to Z), and numeral (0 to 9) or the underscore character ("_").

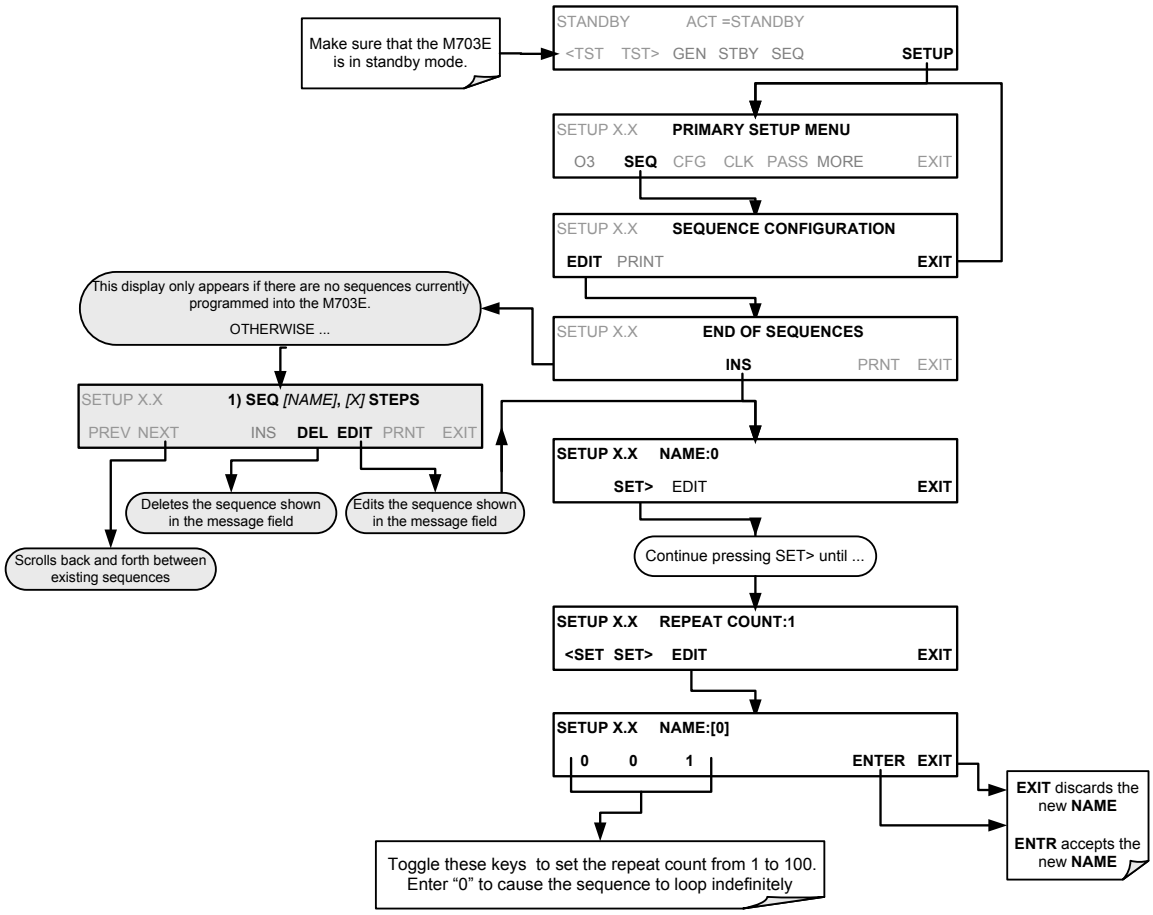
To assign a name to a sequence, press,


Make sure that the M703E is in standby mode.
STANDBY ACT CAL=0.000 LPM
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
GAS SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
This display only appears if there are no sequences currently programmed into the M703E.
OTHERWISE ...
SETUP X.X END OF SEQUENCES
INS PRNT EXIT
SETUP X.X 1) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
SETUP X.X NAME:0
SET> EDIT EXIT
Deletes the sequence shown in the message field
Edits the sequence shown in the message field
Scrolls back and forth between existing sequences
SETUP X.X NAME:[0]
<CH CH> INS DEL [0] ENTER EXIT
Moves the cursor one character left or right.
Inserts a new a character at the cursor location.
Deletes a character at the cursor location.
Toggle this key to cycle through the range of numerals and available characters: ("A – Z"; "0 – 9" & " _ ")
EXIT discards the new NAME
ENTR accepts the new NAME

6.5.1.3. Setting the Repeat Count for a Sequence

The sequence can be set to repeat a certain number of times, from 1 to 100. It can also be set to repeat indefinitely by inputting a zero (0) into the **REPEAT COUNTER**.

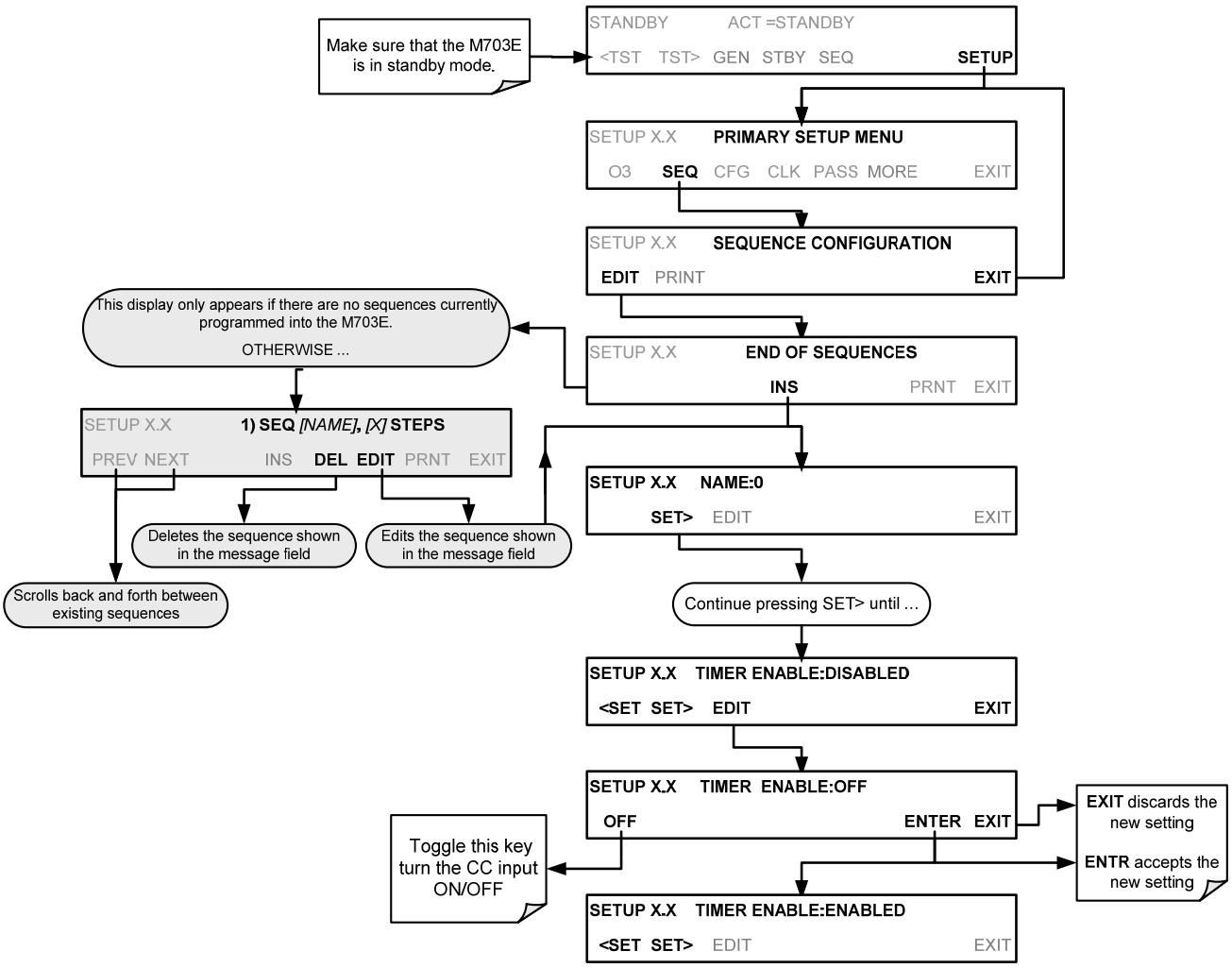
To set th**e REPEAT COUNTER**, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
This display only appears if there are no sequences currently programmed into the M703E.
OTHERWISE ...
SETUP X.X END OF SEQUENCES
INS PRNT EXIT
SETUP X.X 1) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
SETUP X.X NAME:0
SET> EDIT EXIT
Deletes the sequence shown in the message field
Edits the sequence shown in the message field
Scrolls back and forth between existing sequences
Continue pressing SET> until ...
SETUP X.X REPEAT COUNT:1
<SET SET> EDIT EXIT
SETUP X.X NAME:[0]
0 0 1 ENTER EXIT
EXIT discards the new NAME
ENTR accepts the new NAME
Toggle these keys to set the repeat count from 1 to 100.
Enter "0" to cause the sequence to loop indefinitely

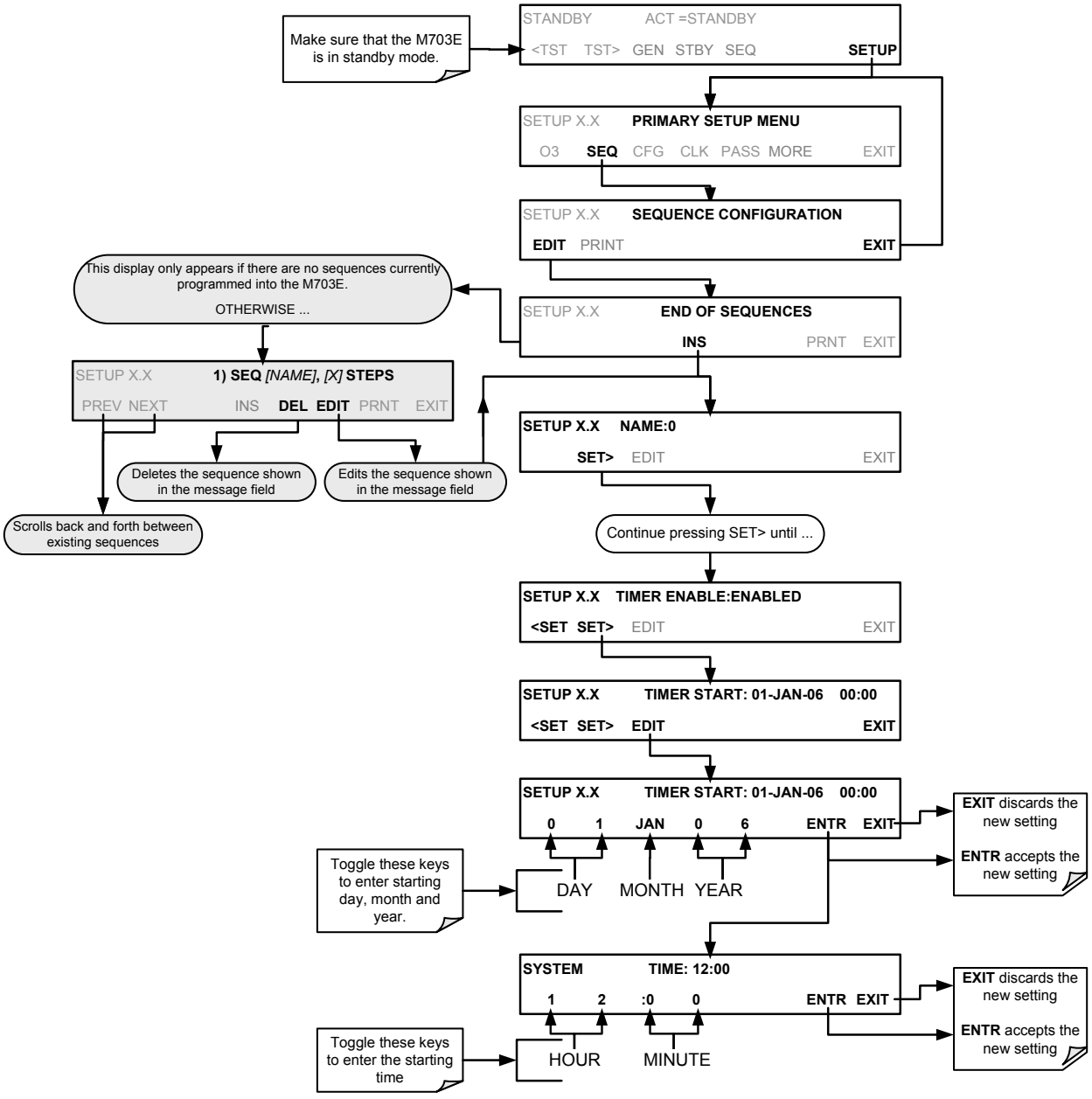
6.5.1.4. Using the M703E's Internal Clock to Trigger Sequences

Sequences can be set to trigger based on the M703E's internal clock. The sequence can be set up to start at a predetermined date and time. It can also be set to repeat after a predetermined delay time.

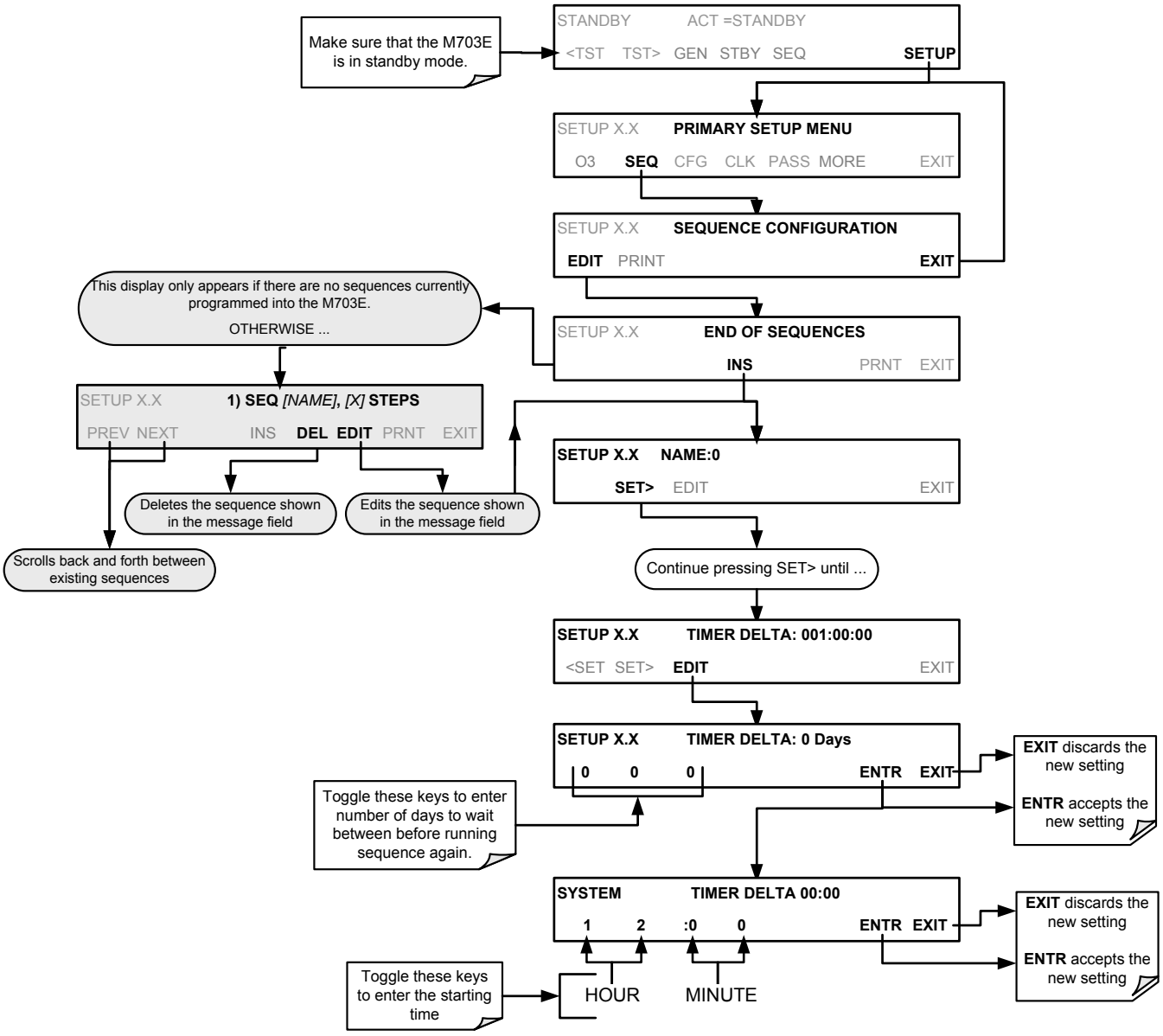
So activate and sequence timer, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
This display only appears if there are no sequences currently programmed into the M703E.
OTHERWISE ...
SETUP X.X END OF SEQUENCES
INS PRNT EXIT
SETUP X.X 1) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
Deletes the sequence shown in the message field
Edits the sequence shown in the message field
Scrolls back and forth between existing sequences
SETUP X.X NAME:0
SET> EDIT EXIT
Continue pressing SET> until ...
SETUP X.X TIMER ENABLE:DISABLED
<SET SET> EDIT EXIT
SETUP X.X TIMER ENABLE:OFF
OFF ENTER EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle this key turn the CC input ON/OFF
SETUP X.X TIMER ENABLE:ENABLED
<SET SET> EDIT EXIT

To specify a starting time for the sequence, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
This display only appears if there are no sequences currently programmed into the M703E.
OTHERWISE ...
SETUP X.X END OF SEQUENCES
INS PRNT EXIT
SETUP X.X 1) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
Deletes the sequence shown in the message field
Edits the sequence shown in the message field
Scrolls back and forth between existing sequences
SETUP X.X NAME:0
SET> EDIT EXIT
Continue pressing SET> until ...
SETUP X.X TIMER ENABLE:ENABLED
<SET SET> EDIT EXIT
SETUP X.X TIMER START: 01-JAN-06 00:00
<SET SET> EDIT EXIT
SETUP X.X TIMER START: 01-JAN-06 00:00
0 1 JAN 0 6 ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle these keys to enter starting day, month and year.
DAY MONTH YEAR
SYSTEM TIME: 12:00
1 2 :0 0 ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle these keys to enter the starting time
HOUR MINUTE

To set the delta timer, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
This display only appears if there are no sequences currently programmed into the M703E.
OTHERWISE ...
SETUP X.X END OF SEQUENCES
INS PRNT EXIT
SETUP X.X 1) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
Deletes the sequence shown in the message field
Edits the sequence shown in the message field
Scrolls back and forth between existing sequences
SETUP X.X NAME:0
SET> EDIT EXIT
Continue pressing SET> until ...
SETUP X.X TIMER DELTA: 001:00:00
<SET SET> EDIT EXIT
SETUP X.X TIMER DELTA: 0 Days
0 0 0 ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle these keys to enter number of days to wait between before running sequence again.
SYSTEM TIMER DELTA 00:00
1 2 :0 0 ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle these keys to enter the starting time
HOUR
MINUTE

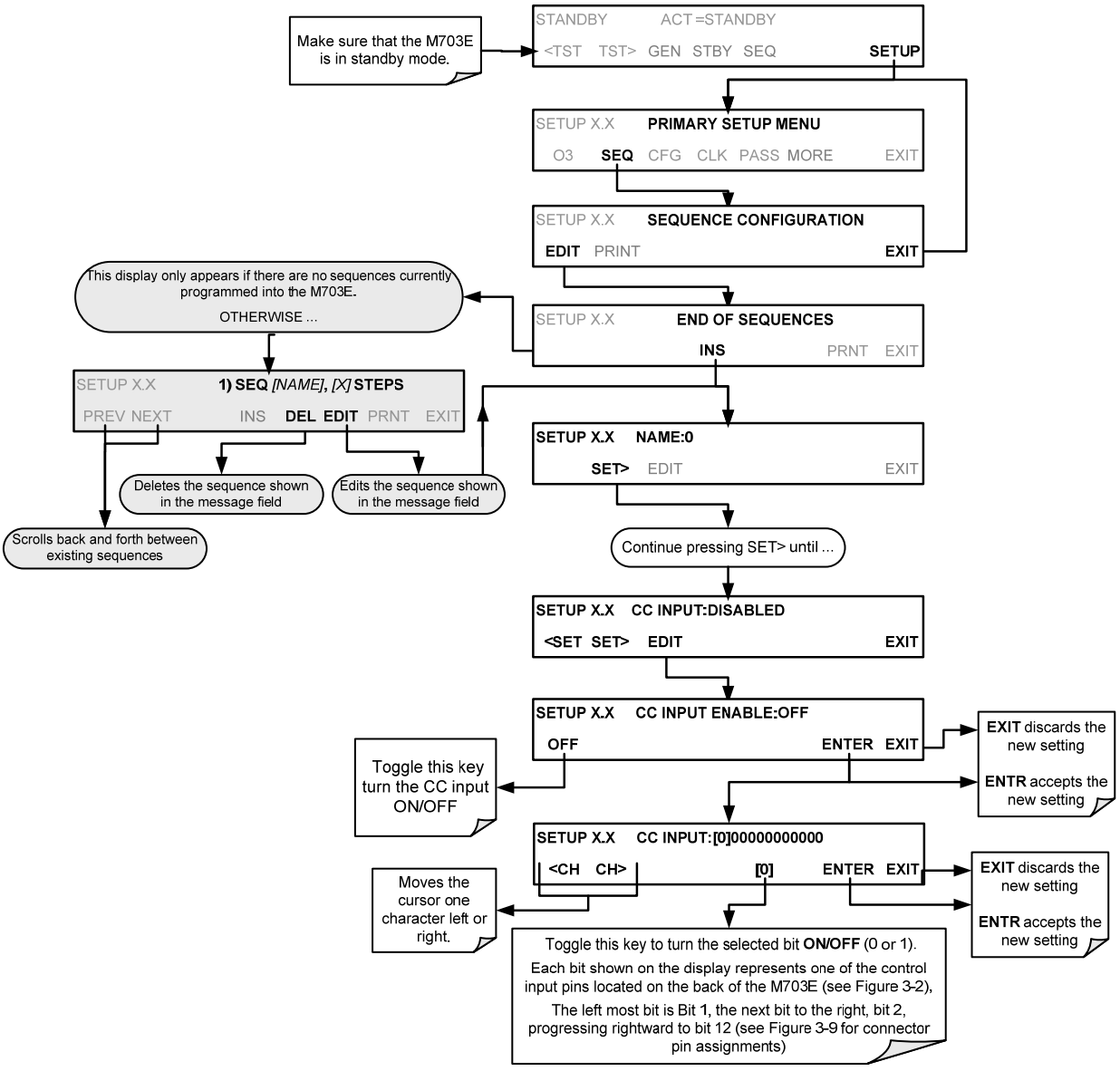
6.5.1.5. Setting Up Control Inputs for a Sequence

The M703E calibrator' control inputs allow the entire sequence to be triggered from an external source. This feature allows the calibrator to operate in a slave mode so that external control sources, such as a data logger can initiate the calibration sequences.

Each of the M703E calibrator's control outputs, located on the back of the instrument (see Figure 3-2)

- 12 separate ON/OFF switches assigned to separate calibration sequences or;
- A 12-bit wide bus allowing the user to define activation codes for up to 4095 separate calibration sequences.

To assign a **CC INPUT** pattern / code to a particular sequence, press.


Make sure that the M703E is in standby mode.
STANDBY ACT=STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
This display only appears if there are no sequences currently programmed into the M703E.
OTHERWISE ...
SETUP X.X END OF SEQUENCES
INS PRNT EXIT
SETUP X.X 1) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
SETUP X.X NAME:0
SET> EDIT EXIT
Deletes the sequence shown in the message field
Edits the sequence shown in the message field
Scrolls back and forth between existing sequences
Continue pressing SET> until ...
SETUP X.X CC INPUT:DISABLED
<SET SET> EDIT EXIT
SETUP X.X CC INPUT ENABLE:OFF
OFF ENTER EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle this key turn the CC input ON/OFF
SETUP X.X CC INPUT:[0]00000000000
<CH CH> [0] ENTER EXIT
EXIT discards the new setting
ENTR accepts the new setting
Moves the cursor one character left or right.
Toggle this key to turn the selected bit ON/OFF (0 or 1).
Each bit shown on the display represents one of the control input pins located on the back of the M703E (see Figure 3-2),
The left most bit is Bit 1, the next bit to the right, bit 2, progressing rightward to bit 12 (see Figure 3-9 for connector pin assignments)

6.5.1.6. Setting Up Control Outputs for a Sequence

The M703E calibrator's control outputs allow the entire sequence to be triggered from an external source. This feature allows the calibrator to control devices that accept logic-level digital inputs, such as programmable logic controllers (PLC's), dataloggers, or digital relays/valve drivers.

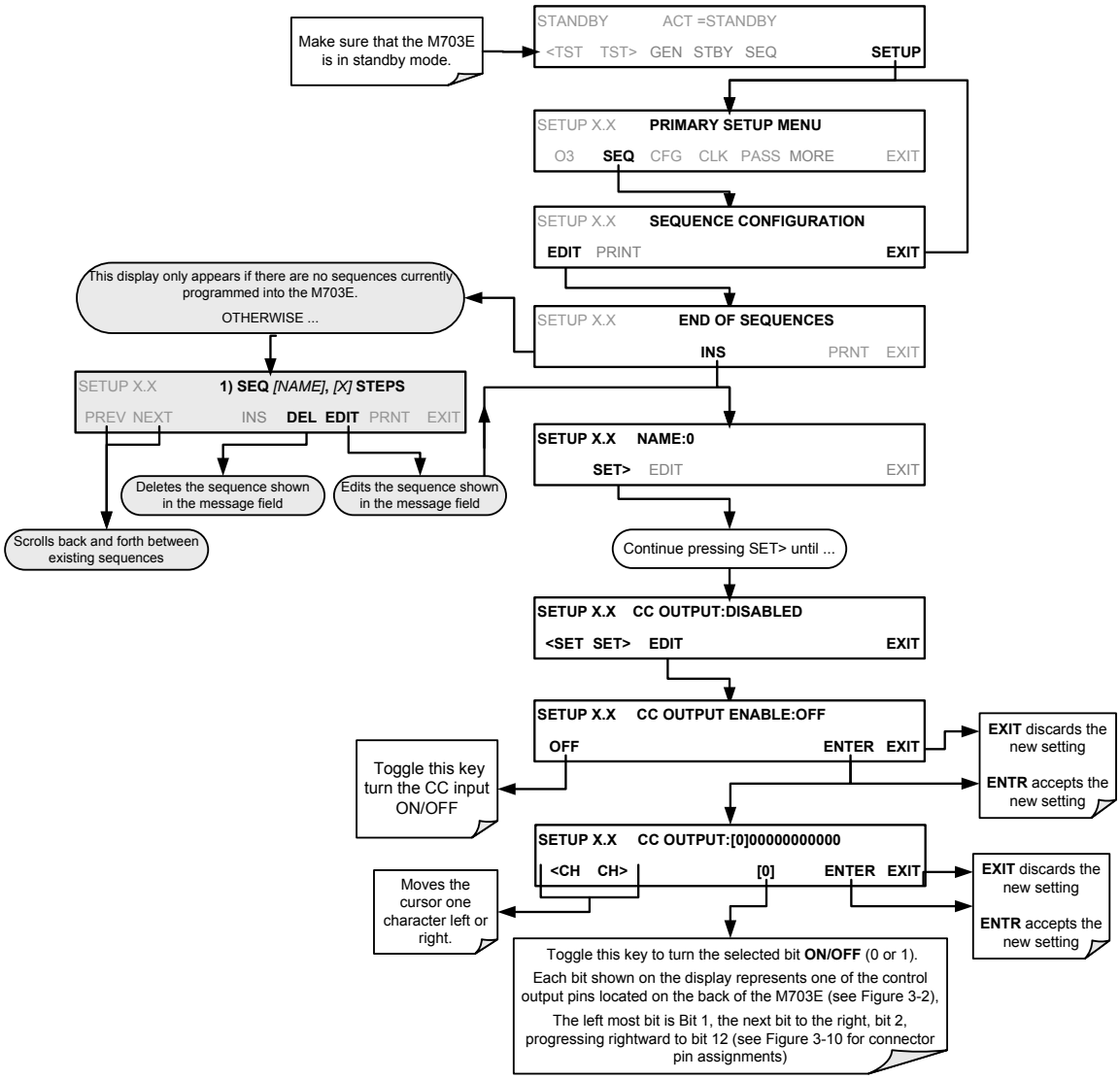
They can be used as:

- 12 separate ON/OFF switches assigned to separate calibration sequences, or;
- A 12-bit wide bus allowing the user to define activation codes for up to 4095 separate calibration sequences.

They can be set to:

- Be active whenever a particular calibration sequence is operating, or;
- Activate/deactivate as individual steps within a calibration sequence are run See Section 6.5.2.5).

To assign a **CC OUTPUT** pattern / code to a particular sequence, press.


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
This display only appears if there are no sequences currently programmed into the M703E.
OTHERWISE ...
SETUP X.X END OF SEQUENCES
INS PRNT EXIT
SETUP X.X 1) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
Deletes the sequence shown in the message field
Edits the sequence shown in the message field
Scrolls back and forth between existing sequences
SETUP X.X NAME:0
SET> EDIT EXIT
Continue pressing SET> until ...
SETUP X.X CC OUTPUT:DISABLED
<SET SET> EDIT EXIT
SETUP X.X CC OUTPUT ENABLE:OFF
OFF ENTER EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle this key turn the CC input ON/OFF
SETUP X.X CC OUTPUT:[0]00000000000
<CH CH> [0] ENTER EXIT
EXIT discards the new setting
ENTR accepts the new setting
Moves the cursor one character left or right.
Toggle this key to turn the selected bit ON/OFF (0 or 1).
Each bit shown on the display represents one of the control output pins located on the back of the M703E (see Figure 3-2),
The left most bit is Bit 1, the next bit to the right, bit 2, progressing rightward to bit 12 (see Figure 3-10 for connector pin assignments)

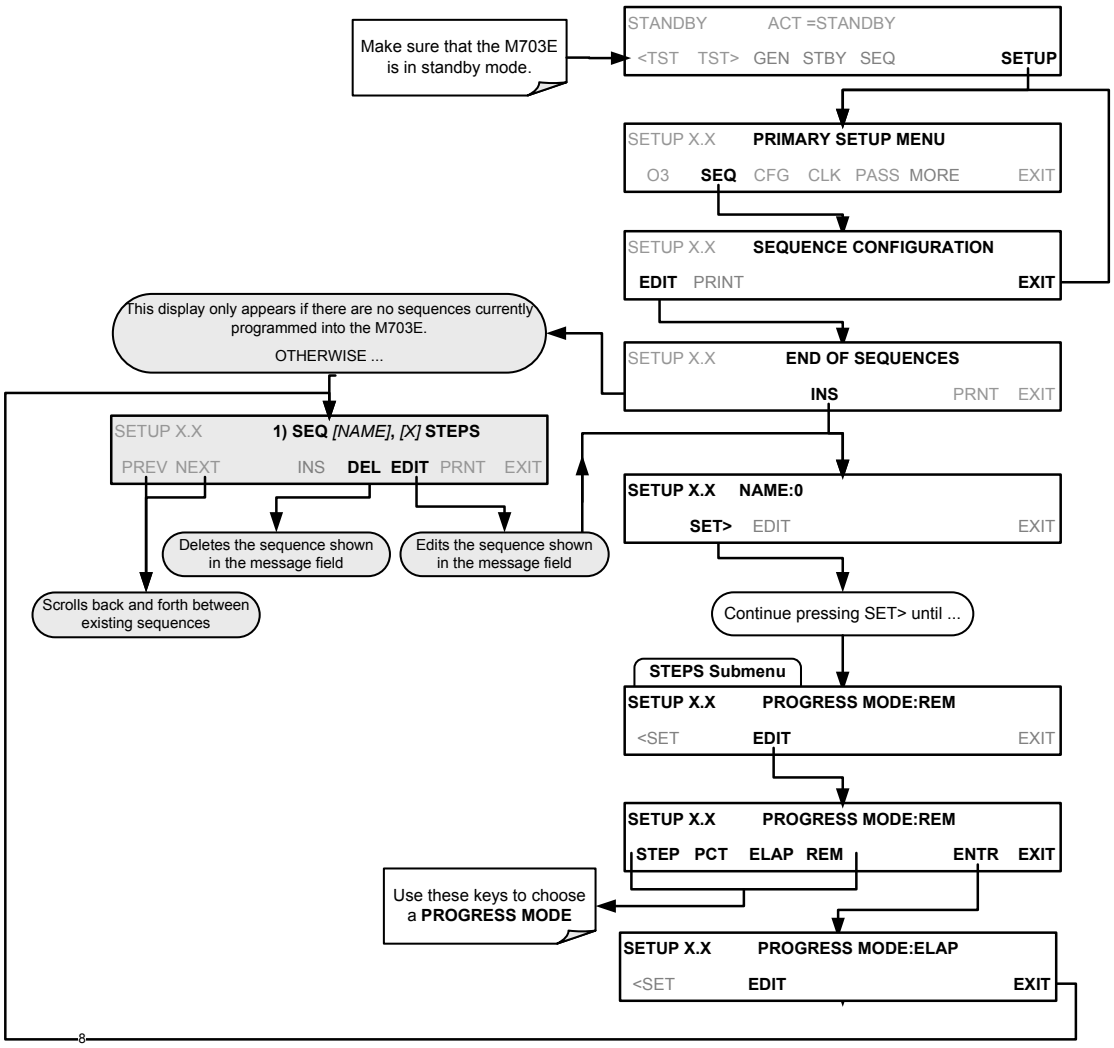
6.5.1.7. Setting the PROGRESS Reporting Mode for the Sequences

As sequences run, the M703E calibrator reports progress by displaying a message in the MODE field of the front panel display (See Figure 3-1). There are several types of report modes available

Table 6-5: Sequence Progress Reporting Mode

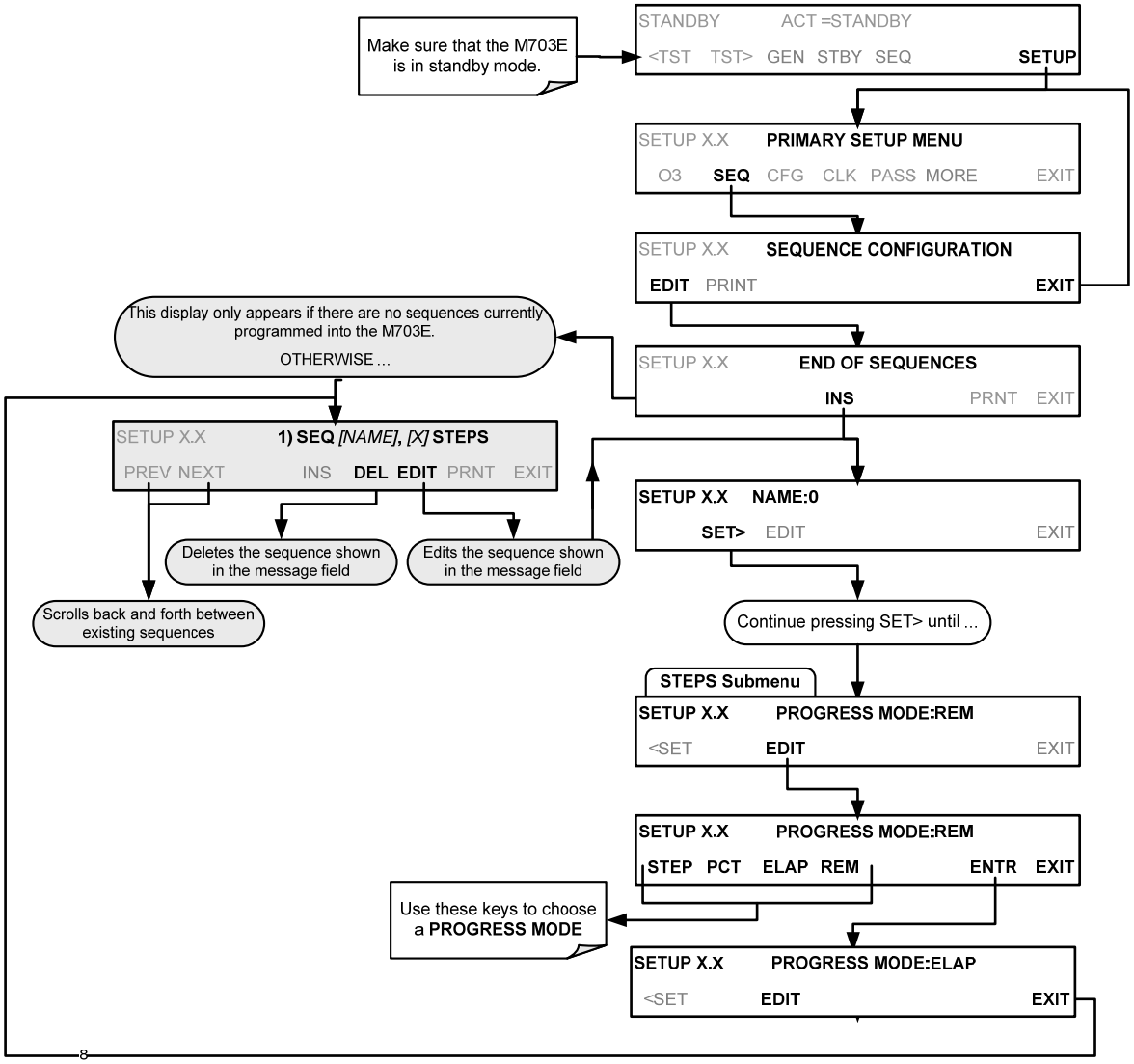
MODE	DESCRIPTION
STEP	• Shows the progress as the sequence name and step number. This is the traditional display. Example: "SO2_Test-2".
PCT	• Shows the progress as a percent (0–100%) of the total sequence duration. Example: "SEQ 48%"
ELAP	• Shows the progress as days, hours, minutes and seconds elapsed, counting up from 0. Example (<1 day): "T+01:30:25" (i.e. 1 hour, 30 minutes, 25 seconds elapsed) Example (>=1 day): "T+1d30:25" (i.e. 1 day, 30 hours, 25 minutes elapsed)
REM	• Shows the progress as days, hours, minutes, and seconds remaining, counting down to 0. Example (<1 day): "T–01:30:25" (i.e. 1 hour, 30 minutes, 25 seconds remaining) Example (>=1 day): "T–1d30:25" (i.e. 1 day, 30 hours, 25 minutes remaining)

To select a PROGRESS report mode, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
This display only appears if there are no sequences currently programmed into the M703E.
OTHERWISE ...
SETUP X.X END OF SEQUENCES
INS PRNT EXIT
SETUP X.X 1) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
SETUP X.X NAME:0
SET> EDIT EXIT
Deletes the sequence shown in the message field
Edits the sequence shown in the message field
Scrolls back and forth between existing sequences
Continue pressing SET> until ...
STEPS Submenu
SETUP X.X PROGRESS MODE:REM
<SET EDIT EXIT
SETUP X.X PROGRESS MODE:REM
STEP PCT ELAP REM ENTR EXIT
Use these keys to choose a PROGRESS MODE
SETUP X.X PROGRESS MODE:ELAP
<SET EDIT EXIT
8

6.5.2. ADDING SEQUENCE STEPS

To insert an instruction step into a sequence, navigate to the **INSERT STEP** submenu by pressing:

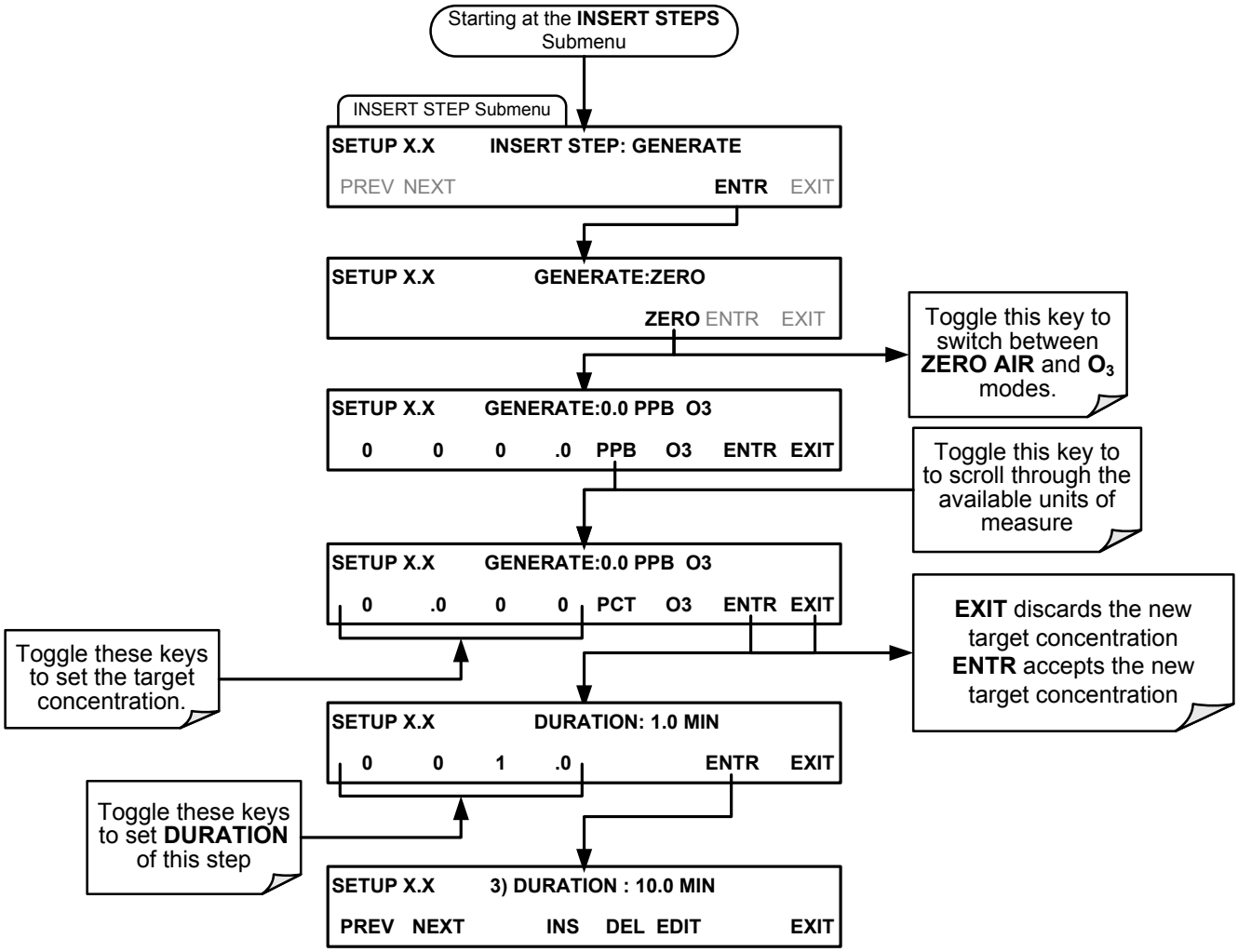

Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
This display only appears if there are no sequences currently programmed into the M703E.
OTHERWISE ...
SETUP X.X END OF SEQUENCES
INS PRNT EXIT
SETUP X.X 1) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
SETUP X.X NAME:0
SET> EDIT EXIT
Deletes the sequence shown in the message field
Edits the sequence shown in the message field
Scrolls back and forth between existing sequences
Continue pressing SET> until ...
STEPS Submenu
SETUP X.X PROGRESS MODE:REM
<SET EDIT EXIT
SETUP X.X PROGRESS MODE:REM
STEP PCT ELAP REM ENTR EXIT
Use these keys to choose a PROGRESS MODE
SETUP X.X PROGRESS MODE:ELAP
<SET EDIT EXIT

6.5.2.1. The Generate Step

This step operates and is programmed similarly to the **GENERATE → AUTO.**

At the end of the programming sequence, the M703E firmware will automatically insert a **DURATION** step that needs to be defined.

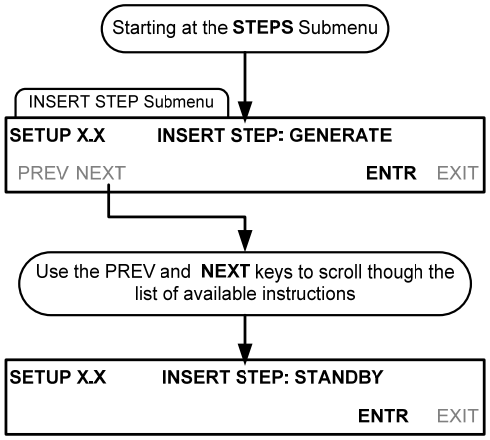
To insert a **GENERATE** step into a sequence, press:


Starting at the INSERT STEPS Submenu
INSERT STEP Submenu
SETUP X.X INSERT STEP: GENERATE
PREV NEXT ENTR EXIT
SETUP X.X GENERATE:ZERO
ZERO ENTR EXIT
Toggle this key to switch between ZERO AIR and O3 modes.
SETUP X.X GENERATE:0.0 PPB O3
0 0 0 .0 PPB O3 ENTR EXIT
Toggle this key to to scroll through the available units of measure
SETUP X.X GENERATE:0.0 PPB O3
0 .0 0 0 PCT O3 ENTR EXIT
EXIT discards the new target concentration
ENTR accepts the new target concentration
Toggle these keys to set the target concentration.
SETUP X.X DURATION: 1.0 MIN
0 0 1 .0 ENTR EXIT
Toggle these keys to set DURATION of this step
SETUP X.X 3) DURATION : 10.0 MIN
PREV NEXT INS DEL EDIT EXIT

6.5.2.2. The STANDBY Step

The **STANDBY** step places the calibrator into **STANDBY** mode

To insert a **STANDBY** step into a sequence, press:

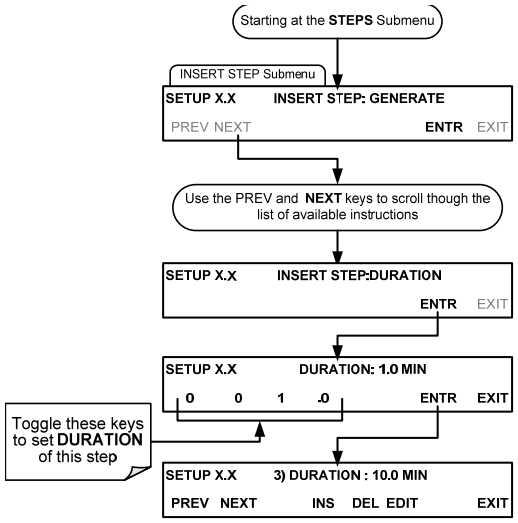

Starting at the **STEPS** Submenu
INSERT STEP Submenu
SETUP X.X INSERT STEP: GENERATE
PREV NEXT ENTR EXIT
Use the PREV and **NEXT** keys to scroll though the list of available instructions
SETUP X.X INSERT STEP: STANDBY
ENTR EXIT

6.5.2.3. The DURATION Step

The duration step causes the M703E to continue performing whatever action was called for by the preceding step of the sequence.

- If that step put the instrument into **STANDBY** mode, the calibrator stays in **STANDBY** mode for the period specified by the **DURATION** step,
- If that step put the instrument into **GENERATE** mode, the will continue to **GENERATE** whatever calibration mixture was programmed into that step for the period specified by the **DURATION** step,

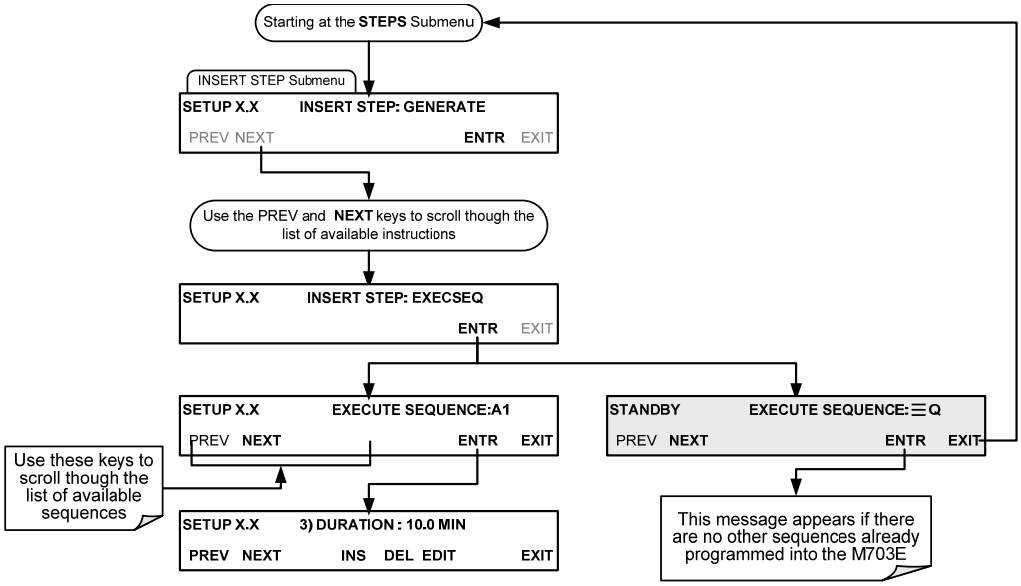
To insert a **DURATION** step into a sequence, press:


Starting at the **STEPS** Submenu
INSERT STEP Submenu
SETUP X.X INSERT STEP: GENERATE
PREV NEXT ENTR EXIT
Use the PREV and **NEXT** keys to scroll though the list of available instructions
SETUP X.X INSERT STEP:DURATION
ENTR EXIT
SETUP X.X DURATION: 1.0 MIN
0 0 1 .0 ENTR EXIT
Toggle these keys to set **DURATION** of this step
SETUP X.X 3) DURATION : 10.0 MIN
PREV NEXT INS DEL EDIT EXIT

6.5.2.4. The EXECSEQ Step

The **EXECSEQ** step allows the sequence to call another, already programmed sequence. This is a very powerful tool in that it allows the user to create a "toolbox" of often-used operations that can then be mixed and matched by an overhead sequence:

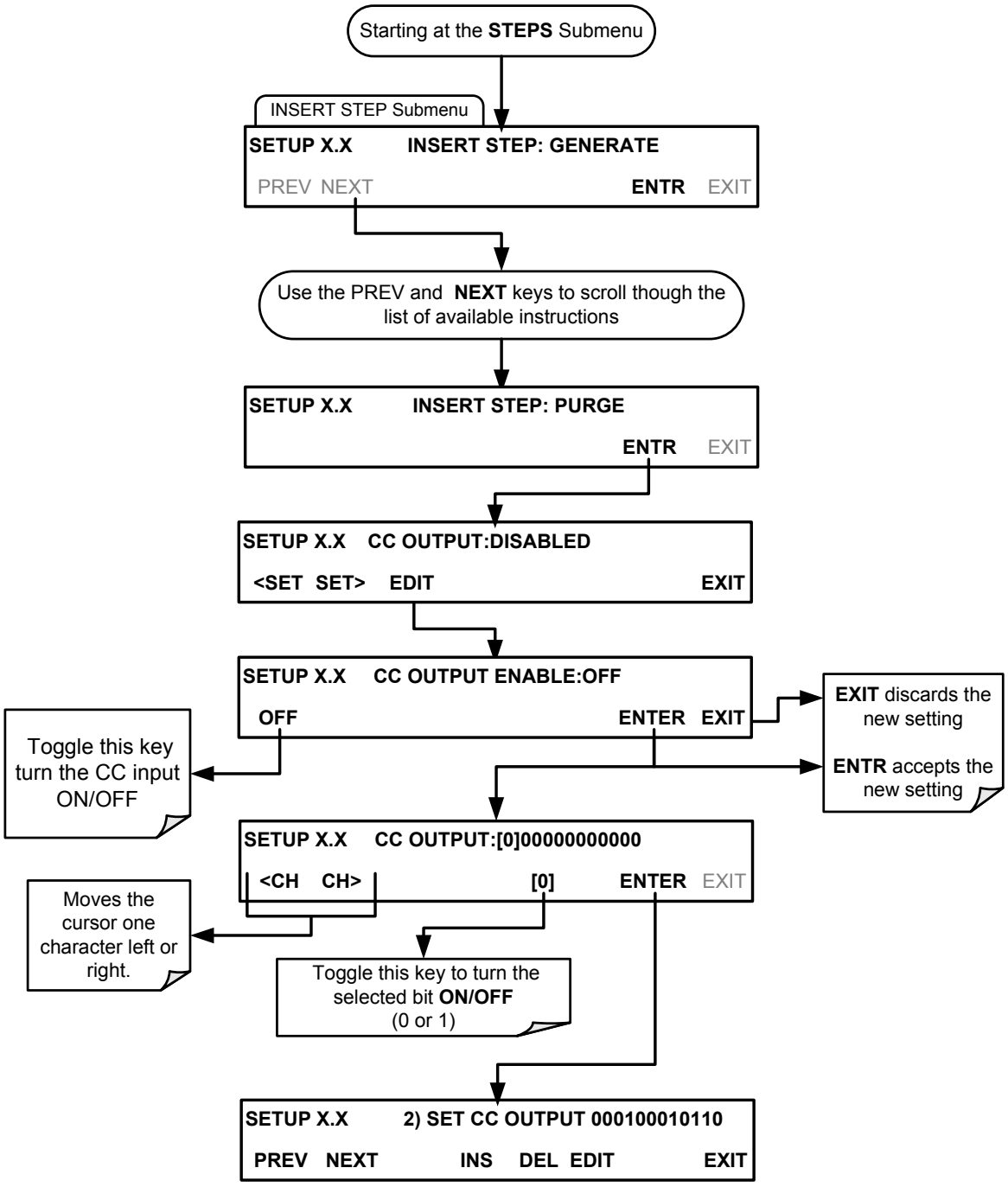
To insert an **EXECSEQ** step into a sequence, press:


Starting at the STEPS Submenu
INSERT STEP Submenu
SETUP X.X INSERT STEP: GENERATE
PREV NEXT ENTR EXIT
Use the PREV and NEXT keys to scroll though the list of available instructions
SETUP X.X INSERT STEP: EXECSEQ
ENTR EXIT
SETUP X.X EXECUTE SEQUENCE:A1
PREV NEXT ENTR EXIT
STANDBY EXECUTE SEQUENCE: ☰Q
PREV NEXT ENTR EXIT
Use these keys to scroll though the list of available sequences
SETUP X.X 3) DURATION : 10.0 MIN
PREV NEXT INS DEL EDIT EXIT
This message appears if there are no other sequences already programmed into the M703E

6.5.2.5. The CC OUTPUT Step

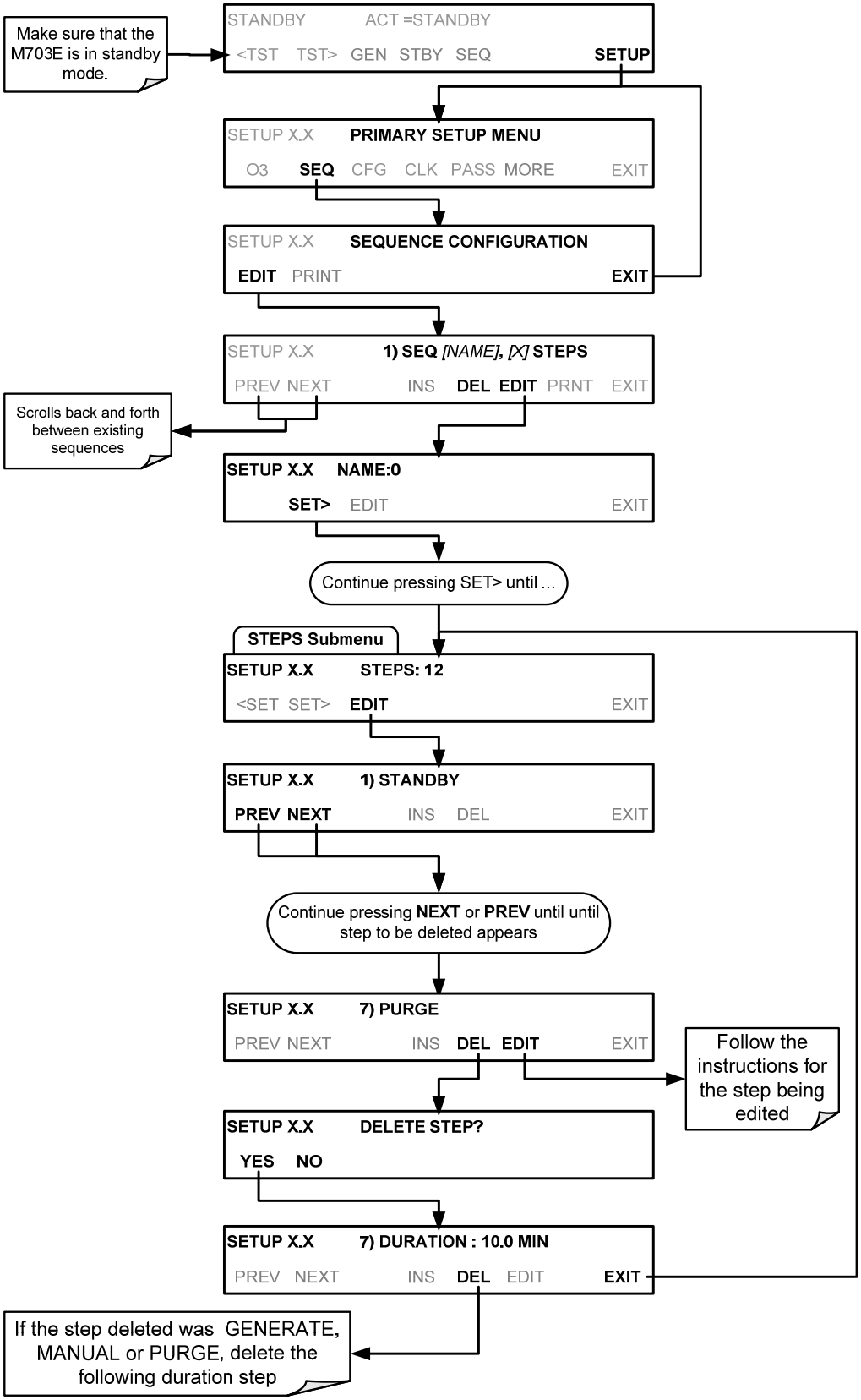
This instruction causes the sequence to set or reset the M703E's digital control outputs. It is very useful in situations where the control outputs are being used to trigger other devices that need to be turned off and on in synch with the operation of the calibrator as it progress through the sequence.

To insert a **CC OUTPUT** step into a sequence, press:


Starting at the **STEPS** Submenu
INSERT STEP Submenu
SETUP X.X INSERT STEP: GENERATE
PREV NEXT ENTR EXIT
Use the PREV and **NEXT** keys to scroll though the list of available instructions
SETUP X.X INSERT STEP: PURGE
ENTR EXIT
SETUP X.X CC OUTPUT:DISABLED
<SET SET> EDIT EXIT
SETUP X.X CC OUTPUT ENABLE:OFF
OFF ENTER EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle this key turn the CC input ON/OFF
SETUP X.X CC OUTPUT:[0]00000000000
<CH CH> [0] ENTER EXIT
Moves the cursor one character left or right.
Toggle this key to turn the selected bit **ON/OFF** (0 or 1)
SETUP X.X 2) SET CC OUTPUT 000100010110
PREV NEXT INS DEL EDIT EXIT

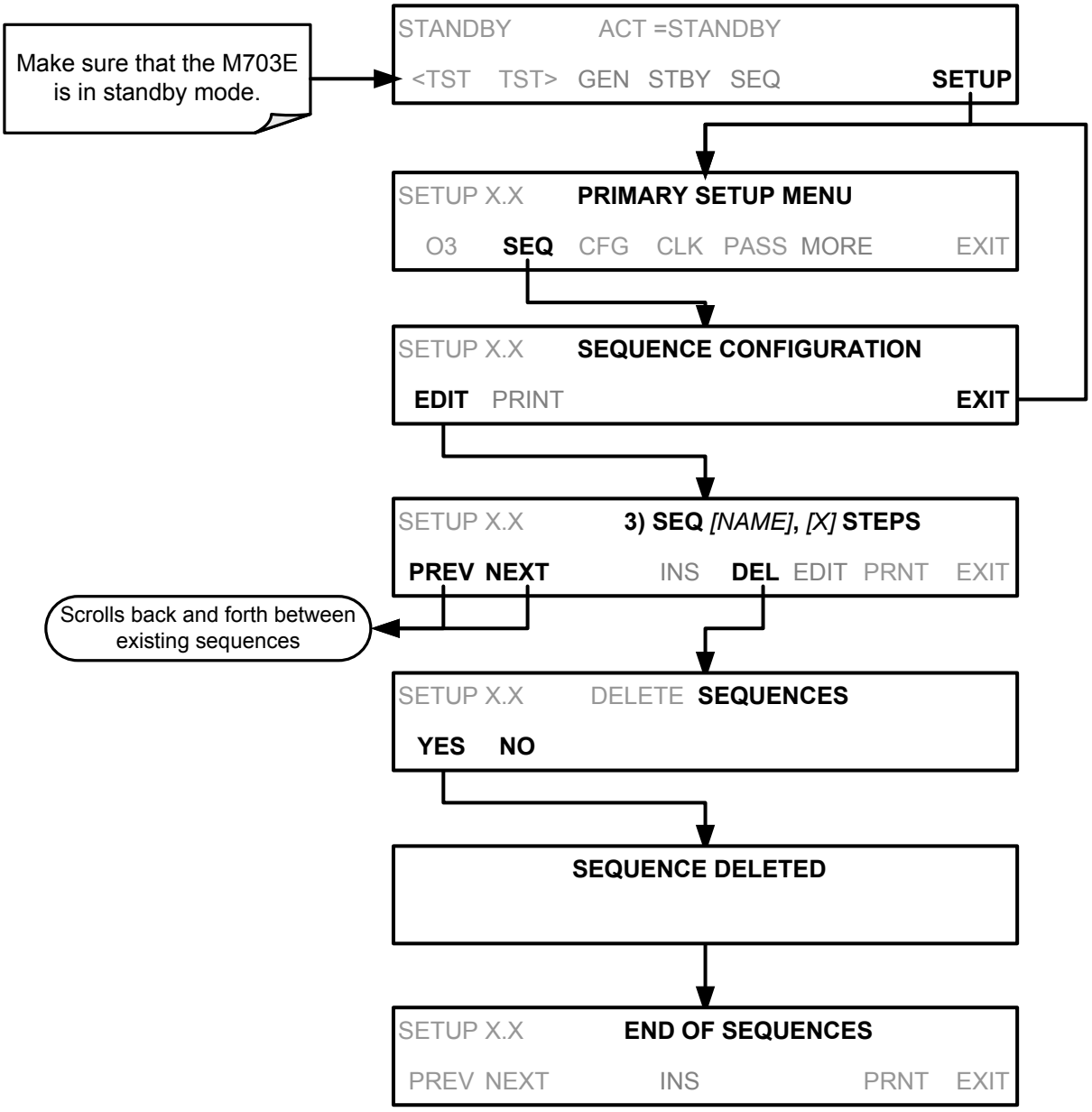
6.5.2.6. Deleting or Editing an Individual Step in a Sequence

To delete or edit an individual step in an existing Sequence, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
SETUP X.X 1) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
Scrolls back and forth between existing sequences
SETUP X.X NAME:0
SET> EDIT EXIT
Continue pressing SET> until ...
STEPS Submenu
SETUP X.X STEPS: 12
<SET SET> EDIT EXIT
SETUP X.X 1) STANDBY
PREV NEXT INS DEL EXIT
Continue pressing NEXT or PREV until until step to be deleted appears
SETUP X.X 7) PURGE
PREV NEXT INS DEL EDIT EXIT
Follow the instructions for the step being edited
SETUP X.X DELETE STEP?
YES NO
SETUP X.X 7) DURATION : 10.0 MIN
PREV NEXT INS DEL EDIT EXIT
If the step deleted was GENERATE, MANUAL or PURGE, delete the following duration step

6.5.3. DELETING A SEQUENCE

To delete a sequence from the M703E calibrator's memory, press:

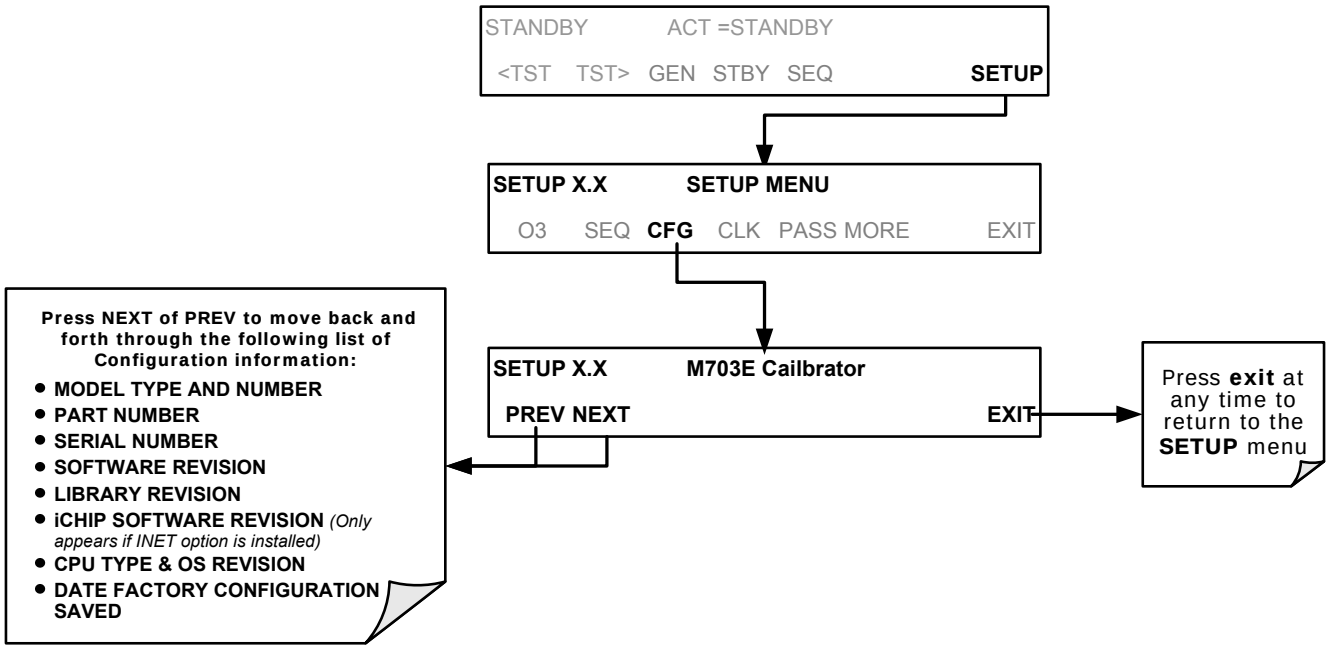

Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SEQUENCE CONFIGURATION
EDIT PRINT EXIT
SETUP X.X 3) SEQ [NAME], [X] STEPS
PREV NEXT INS DEL EDIT PRNT EXIT
Scrolls back and forth between existing sequences
SETUP X.X DELETE SEQUENCES
YES NO
SEQUENCE DELETED
SETUP X.X END OF SEQUENCES
PREV NEXT INS PRNT EXIT

6.6. SETUP → CFG

Pressing the CFG key displays the instrument's configuration information. This display lists the calibrator model, serial number, firmware revision, software library revision, CPU type and other information.

Use this information to identify the software and hardware when contacting customer service.

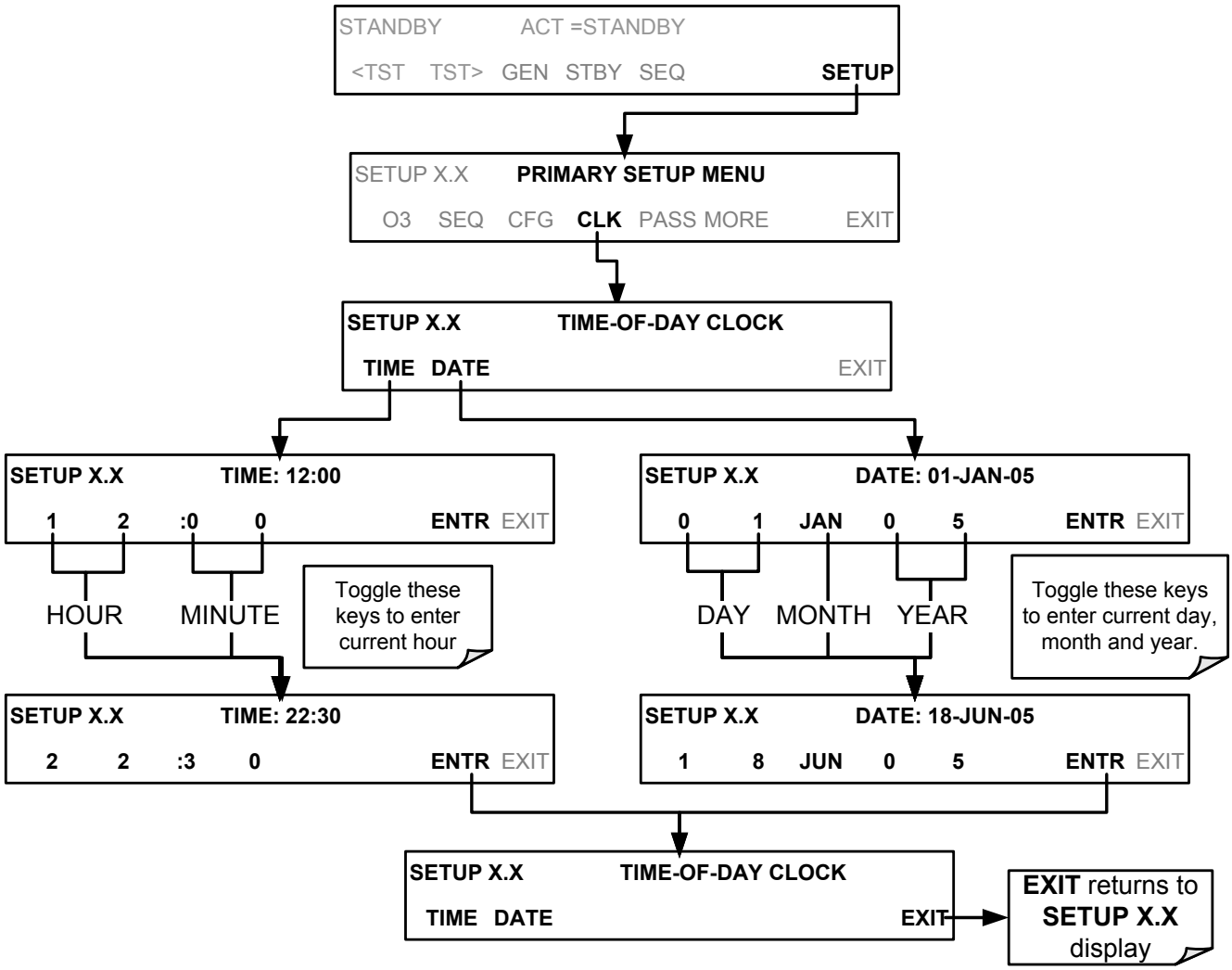
Special instrument or software features or installed options may also be listed here.


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X M703E Cailbrator
PREV NEXT EXIT
Press NEXT of PREV to move back and forth through the following list of Configuration information:
MODEL TYPE AND NUMBER
PART NUMBER
SERIAL NUMBER
SOFTWARE REVISION
LIBRARY REVISION
iCHIP SOFTWARE REVISION (Only appears if INET option is installed)
CPU TYPE & OS REVISION
DATE FACTORY CONFIGURATION SAVED
Press exit at any time to return to the SETUP menu

6.7. SETUP → CLK

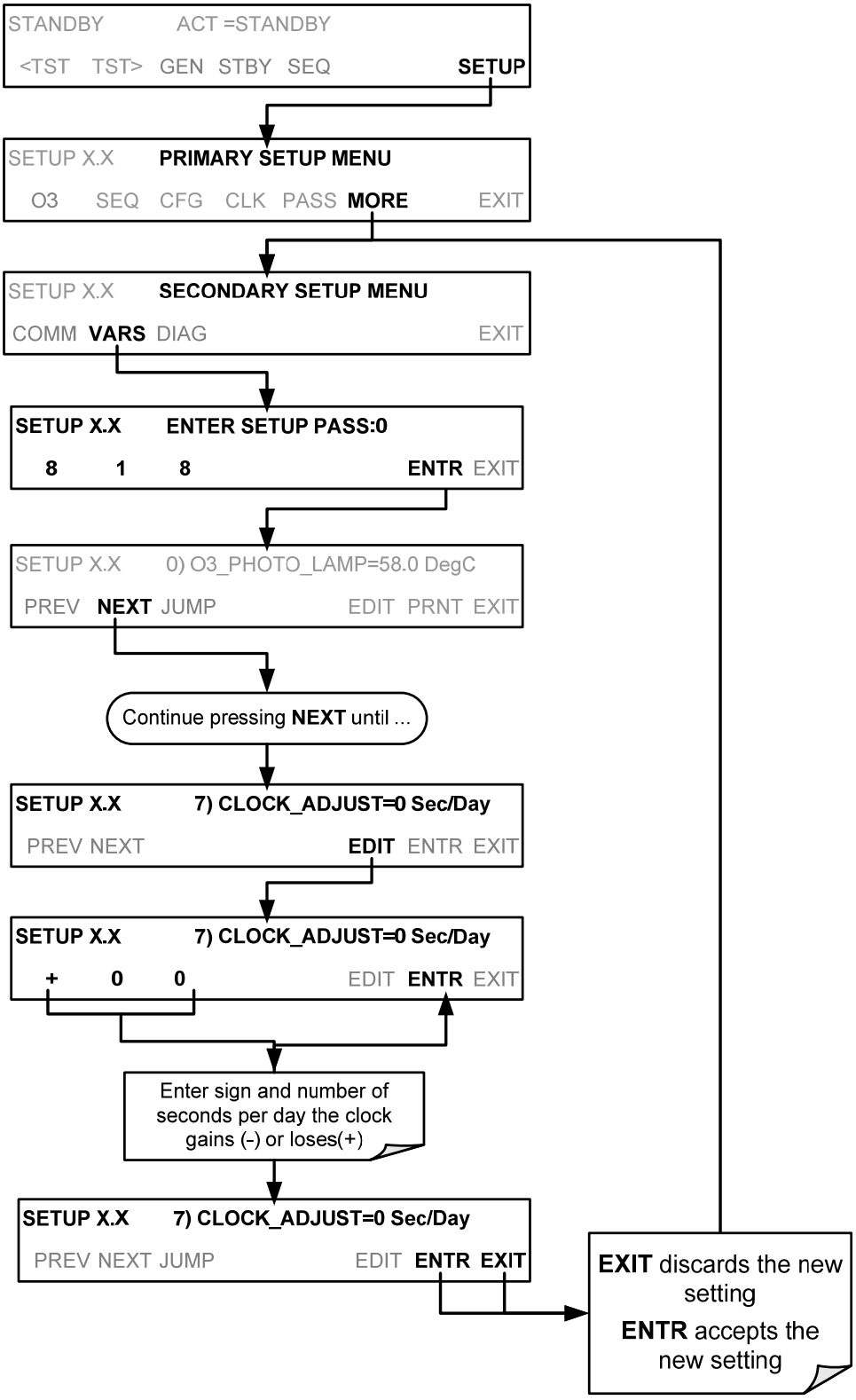
6.7.1. SETTING THE INTERNAL CLOCK'S TIME AND DAY

The M703E has a time of day clock that supports the **DURATION** step of the calibration sequence feature, time of day TEST function, and time stamps on most COM port messages. To set the clock's time and day, press:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X TIME-OF-DAY CLOCK
TIME DATE EXIT
SETUP X.X TIME: 12:00
1 2 :0 0 ENTR EXIT
HOUR MINUTE
Toggle these keys to enter current hour
SETUP X.X TIME: 22:30
2 2 :3 0 ENTR EXIT
SETUP X.X DATE: 01-JAN-05
0 1 JAN 0 5 ENTR EXIT
DAY MONTH YEAR
Toggle these keys to enter current day, month and year.
SETUP X.X DATE: 18-JUN-05
1 8 JUN 0 5 ENTR EXIT
SETUP X.X TIME-OF-DAY CLOCK
TIME DATE EXIT
EXIT returns to SETUP X.X display

6.7.2. ADJUSTING THE INTERNAL CLOCK'S SPEED

In order to compensate for CPU clocks which run faster or slower, you can adjust a variable called **CLOCK_ADJ** to speed up or slow down the clock by a fixed amount every day. To change this variable, press:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER SETUP PASS:0
8 1 8 ENTR EXIT
SETUP X.X 0) O3_PHOTO_LAMP=58.0 DegC
PREV NEXT JUMP EDIT PRNT EXIT
Continue pressing NEXT until ...
SETUP X.X 7) CLOCK_ADJUST=0 Sec/Day
PREV NEXT EDIT ENTR EXIT
SETUP X.X 7) CLOCK_ADJUST=0 Sec/Day
+ 0 0 EDIT ENTR EXIT
Enter sign and number of seconds per day the clock gains (-) or loses(+)
SETUP X.X 7) CLOCK_ADJUST=0 Sec/Day
PREV NEXT JUMP EDIT ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting

6.8. SETUP → PASS

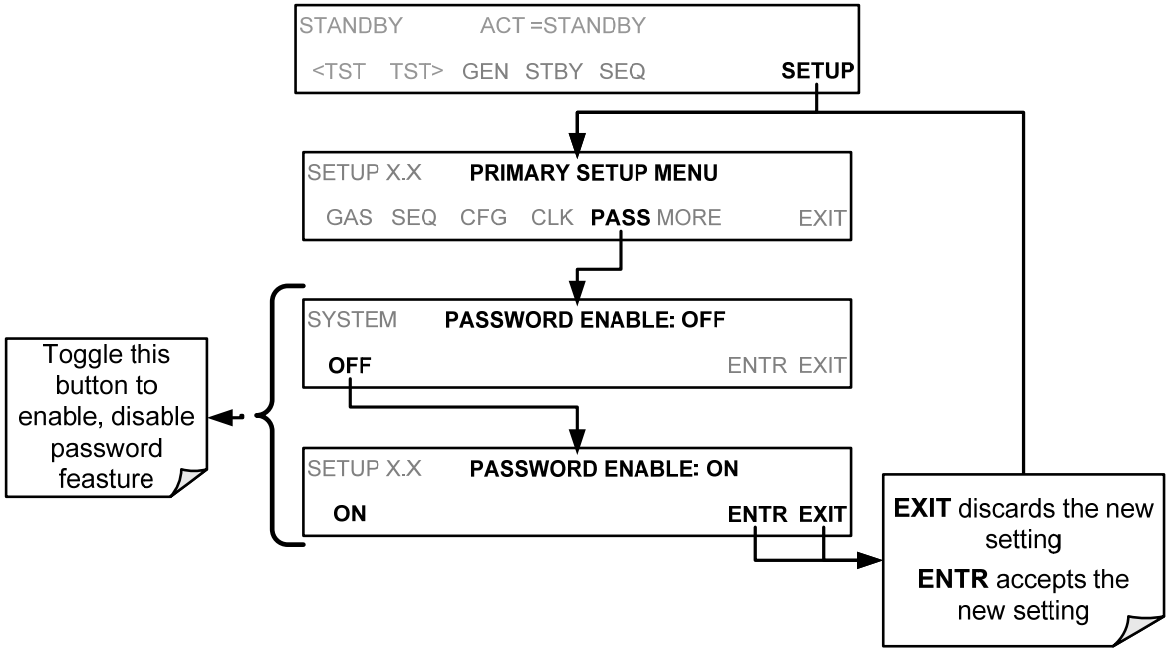
The M703E provides password protection of the calibration and setup functions to prevent unauthorized adjustments. When the passwords have been enabled in the **PASS** menu item, the system will prompt the user for a password anytime a password-protected function is requested.

There are three levels of password protection, which correspond to operator, maintenance and configuration functions. Each level allows access to all of the functions in the previous level.

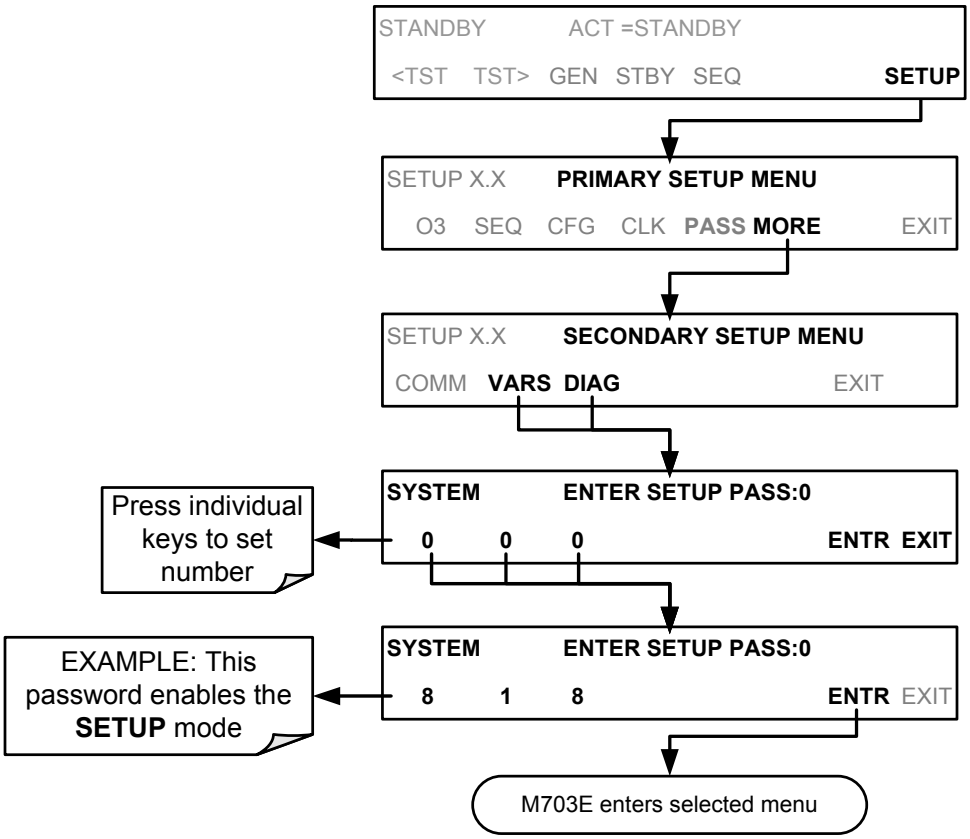
Table 6-6: Password Levels

PASSWORD	LEVEL	MENU ACCESS ALLOWED
No password	Operator	All functions of the MAIN menu: **TEST, GEN,** initiate **SEQ , MSG, CLR**
101	Maintenance	Access to Primary and Secondary Setup Menus except for **VARS** & **DIAG**
818	Configuration	Secondary SETUP Submenus **VARS** and **DIAG**

To enable or disable passwords, press:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
GAS SEQ CFG CLK PASS MORE EXIT
SYSTEM PASSWORD ENABLE: OFF
OFF ENTR EXIT
SETUP X.X PASSWORD ENABLE: ON
ON ENTR EXIT
Toggle this button to enable, disable password feasture
EXIT discards the new setting
ENTR accepts the new setting

Example: If all passwords are enabled, the following keypad sequence would be required to enter the VARS or DIAG submenus:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SYSTEM ENTER SETUP PASS:0
0 0 0 ENTR EXIT
Press individual keys to set number
SYSTEM ENTER SETUP PASS:0
8 1 8 ENTR EXIT
EXAMPLE: This password enables the SETUP mode
M703E enters selected menu

NOTE

The instrument still prompts for a password when entering the VARS and DIAG menus, even if passwords are disabled, but it displays the default password (818) upon entering these menus. The user only has to press ENTR to access the password-protected menus but does not have to enter the required number code.

6.9. SETUP → DIAG → TEST CHAN OUTPUT: USING THE TEST CHANNEL ANALOG OUTPUT

The M703E calibrator comes equipped with one analog output. It can be set by the user to carry the current signal level of any one of the parameters listed in Table 6-8 and will output an analog VDC signal that rises and falls in relationship with the value of the parameter.

Pin-outs for the analog output connector at the rear panel of the instrument are:

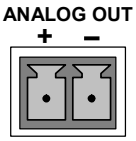


Figure 6-2: M703E the TEST CHANNEL Connector

6.9.1. CONFIGURING THE TEST CHANNEL ANALOG OUTPUT

6.9.1.1. The Analog I/O Configuration Submenu.

Table 6-7 lists the analog I/O functions that are available in the M703E calibrator.

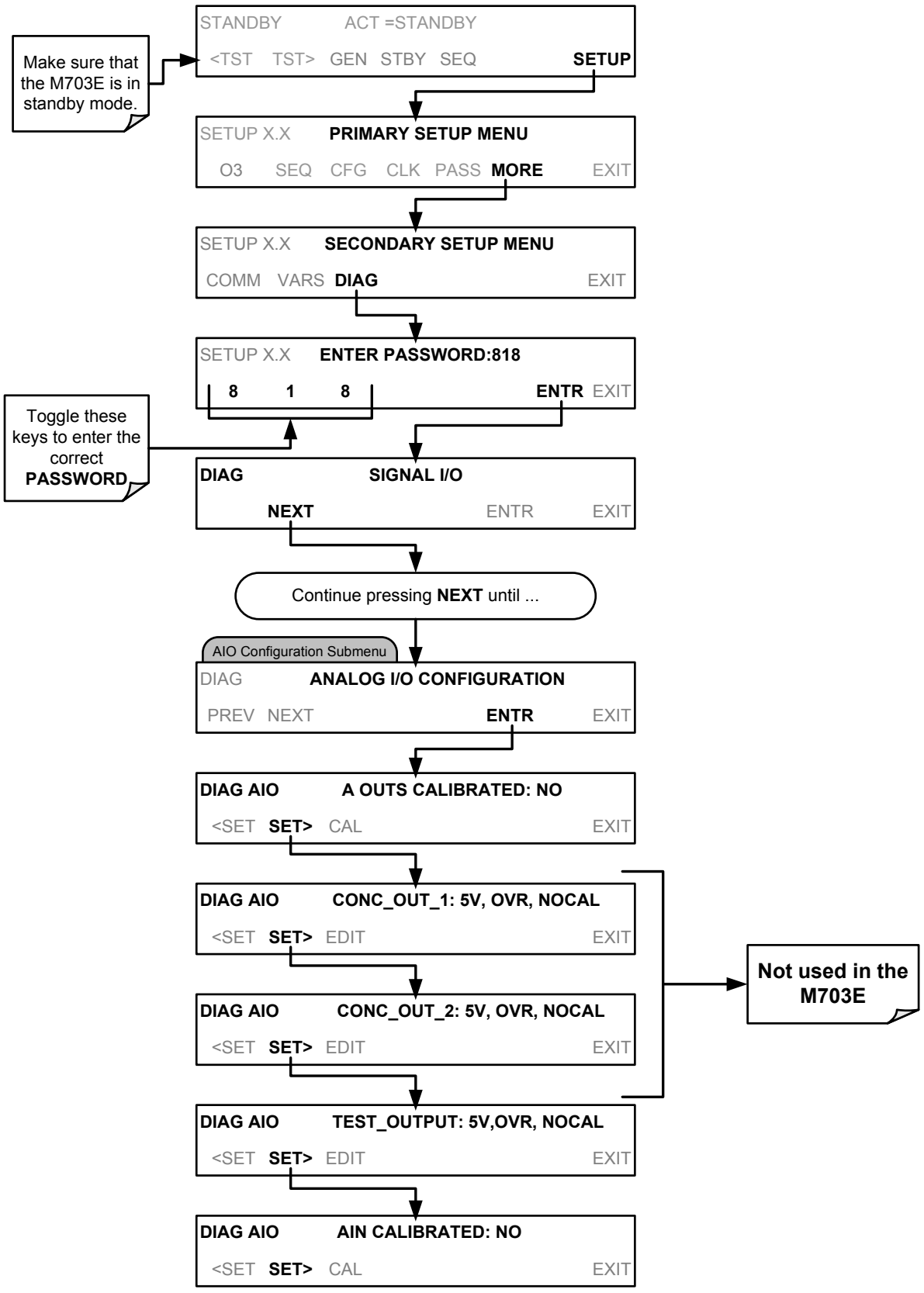
Table 6-7: DIAG - Analog I/O Functions

SUB MENU	FUNCTION
AOUTS CALIBRATED:	Shows the status of the analog output calibration (YES/NO) and initiates a calibration of all analog output channels.
CAL_OUT_1:	**NOT USED ON THE M703E**
CAL_OUT_2	
TEST OUTPUT	Configures the **11** analog output: **RANGE**[1]: Selects the DCV full-scale value of the output. **OVERRANGE:** Turns the ± 5% over-range feature ON/OFF for this output channel. **REC_OFS**[1]: Sets a voltage offset (not available when **RANGE** is set to **CURR**ent loop. **AUTO_CAL**[1]: Sets the channel for automatic or manual calibration **CALIBRATED**[1]**:** Performs the same calibration as **AOUT CALIBRATED**, but on this one channel only.
AIN CALIBRATED	Shows the calibration status (YES/NO) and initiates a calibration of the analog to digital converter circuit on the motherboard.
[1]Changes to **RANGE** or **REC_OFS** require recalibration of this output.	

To configure the analyzer's **TEST CHANNEL**, set the electronic signal type of each channel and calibrate the outputs. This consists of:

10. Choosing a **TEST CHANNEL** function to be output on the channel.
11. Selecting a signal level that matches the input requirements of the recording device attached to the channel.
12. Determining if the over-range feature is needed and turn it on or off accordingly.
13. Adding a bipolar recorder offset to the signal if required (Section6.9.1.5).
14. Calibrating the output channel. This can be done automatically or manually for each channel (see Sections 6.9.2).

To access the analog I/O configuration sub menu, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD:818
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
NEXT ENTR EXIT
Continue pressing NEXT until ...
AIO Configuration Submenu
DIAG ANALOG I/O CONFIGURATION
PREV NEXT ENTR EXIT
DIAG AIO A OUTS CALIBRATED: NO
<SET SET> CAL EXIT
DIAG AIO CONC_OUT_1: 5V, OVR, NOCAL
<SET SET> EDIT EXIT
DIAG AIO CONC_OUT_2: 5V, OVR, NOCAL
<SET SET> EDIT EXIT
DIAG AIO TEST_OUTPUT: 5V,OVR, NOCAL
<SET SET> EDIT EXIT
DIAG AIO AIN CALIBRATED: NO
<SET SET> CAL EXIT
Not used in the M703E

6.9.1.2. Selecting a Test Channel Function to Output

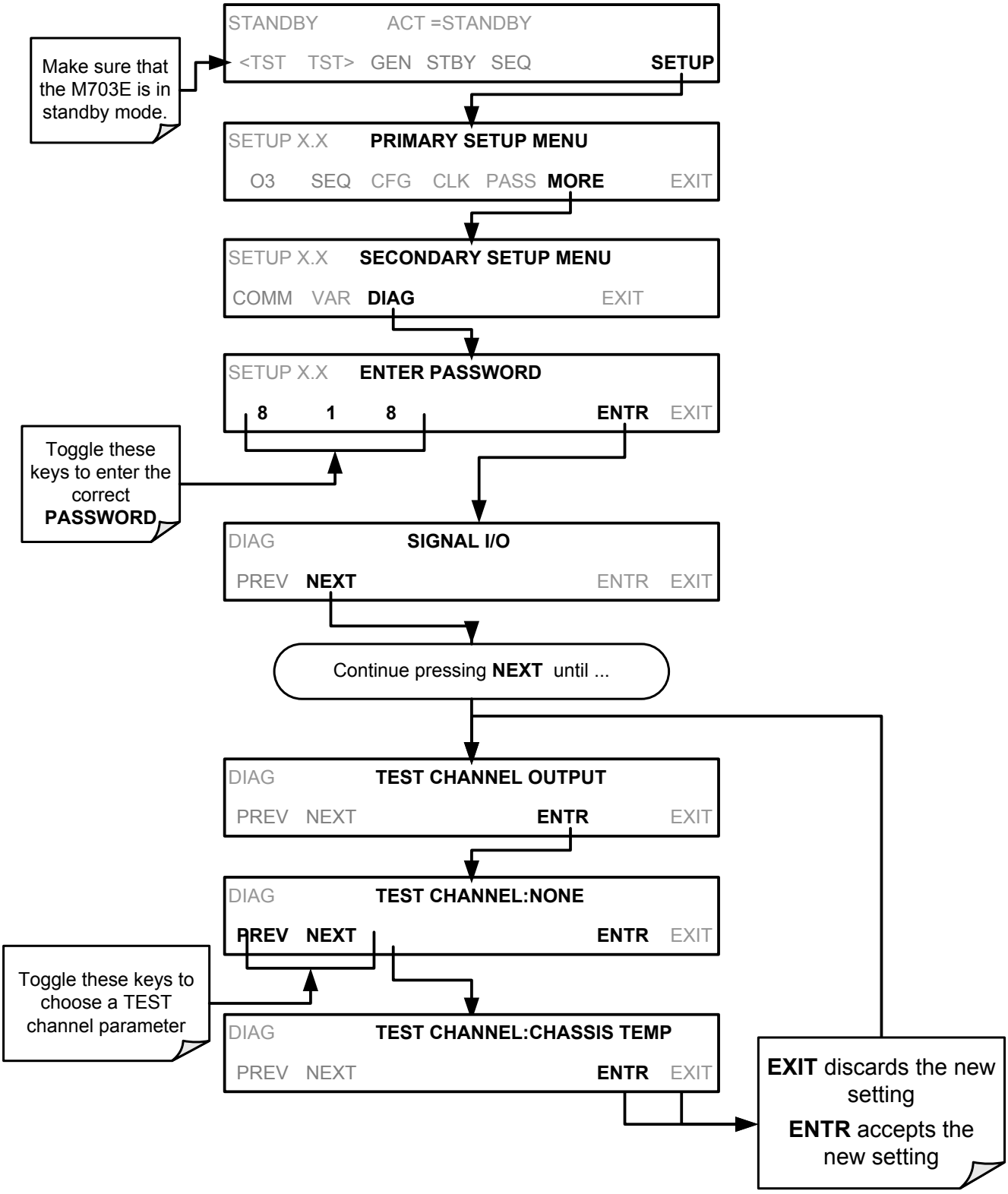
The Test Functions available to be reported are:

Table 6-8: Test Channels Functions Available on the M703E's Analog Output

TEST CHANNEL	DESCRIPTION	ZERO	FULL SCALE
NONE	**TEST CHANNEL IS TURNED OFF**		
O3 PHOTO MEAS	The raw output of the photometer during its measure cycle	0 mV	5000 mV*
O3 PHOTO REF	The raw output of the photometer during its reference cycle	0 mV	5000 mV*
O3 GEN REF	The raw output of the O_3 generator's reference detector	0 mV	5000 mV*
OUTPUT FLOW	The gas flow being output through the CAL GAS outlets on the back of the instrument	0 cm^3/min	5,000 cm^3/min
REGULATOR PRESSURE	The gas pressure measured by the O_3 generator pressure sensor	0 PSIG	105 PSIG
SAMPLE PRESSURE	The pressure of gas in the photometer absorption tube	0 "Hg	40 "Hg-In-A
SAMPLE FLOW	The gas flow rate through the photometer	0 cm^3/min	1000 cc^3/min
SAMPLE TEMP	The temperature of gas in the photometer absorption tube	0 C°	70 C°
PHOTO LAMP TEMP	The temperature of the photometer UV lamp	0 C°	70 C°
O3 LAMP TEMP	The temperature of the O_3 generator's UV lamp	0 mV	5000 mV
CHASSIS TEMP	The temperature inside the M703E's chassis (same as **BOX TEMP**)	0 C°	70 C°
O3 PHOTO CONC	The current concentration of O_3 being measured by the photometer.	0 C°	1 ppm

Once a function is selected, the instrument not only begins to output a signal on the analog output, but also adds **TEST** to the list of Test Functions viewable via the Front Panel Display.

To activate the **TEST** Channel and select a function press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VAR DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
Continue pressing NEXT until ...
DIAG TEST CHANNEL OUTPUT
PREV NEXT ENTR EXIT
DIAG TEST CHANNEL:NONE
PREV NEXT ENTR EXIT
Toggle these keys to choose a TEST channel parameter
DIAG TEST CHANNEL:CHASSIS TEMP
PREV NEXT ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting

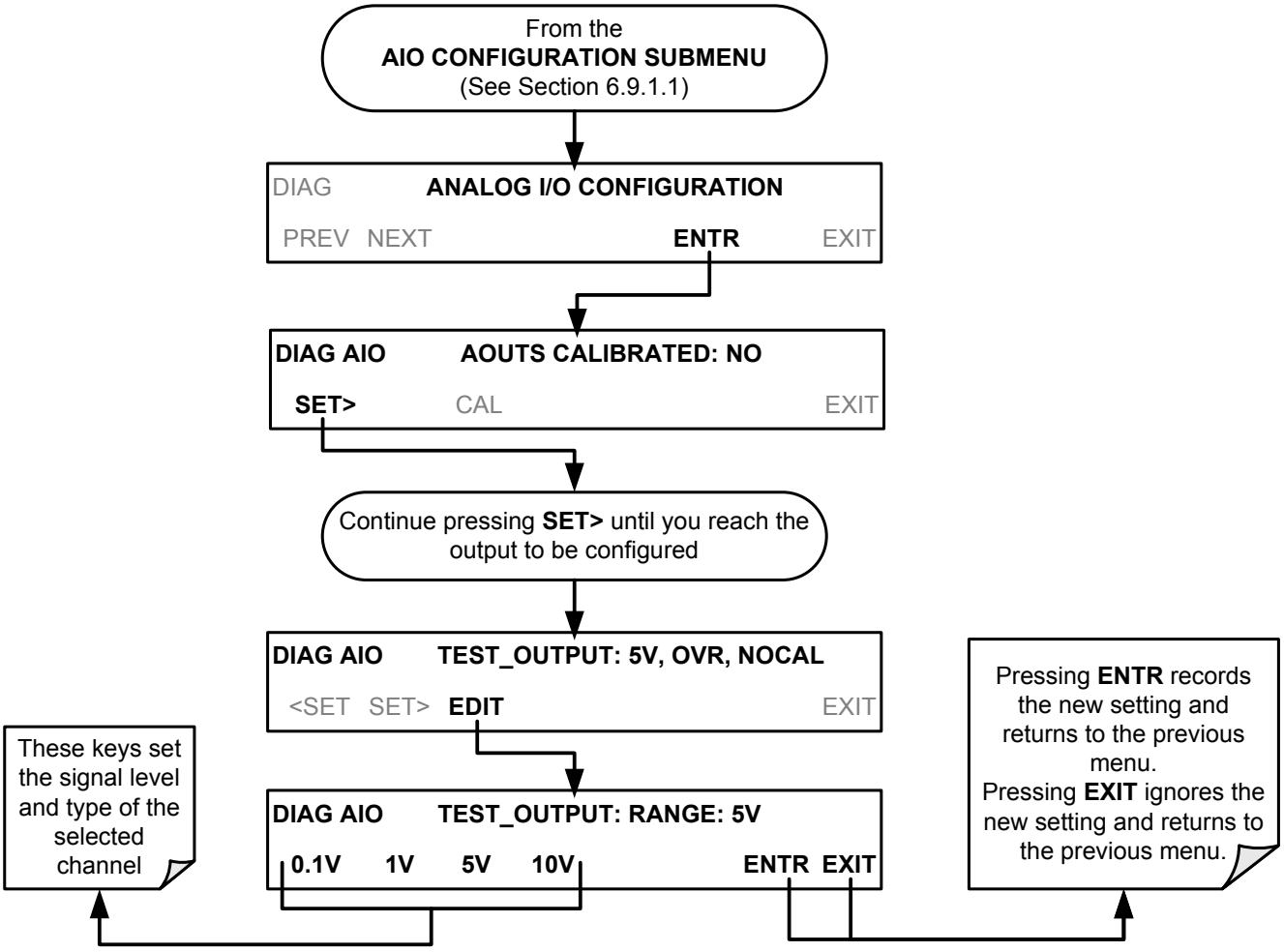
6.9.1.3. TEST CHANNEL VOLTAGE RANGE Configuration

In its standard configuration the analog outputs is set to output a 0 – 5 VDC signals. Several other output ranges are available (see Table 7-5). Each range has is usable from -5% to + 5% of the rated span.

Table 6-9: Analog Output Voltage Range Min/Max

RANGE SPAN	MINIMUM OUTPUT	MAXIMUM OUTPUT
0-100 mVDC	-5 mVDC	105 mVDC
0-1 VDC	-0.05 VDC	1.05 VDC
0-5 VDC	-0.25 VDC	5.25 VDC
0-10 VDC	-0.5 VDC	10.5 VDC
The default offset for all ranges is 0 VDC.		

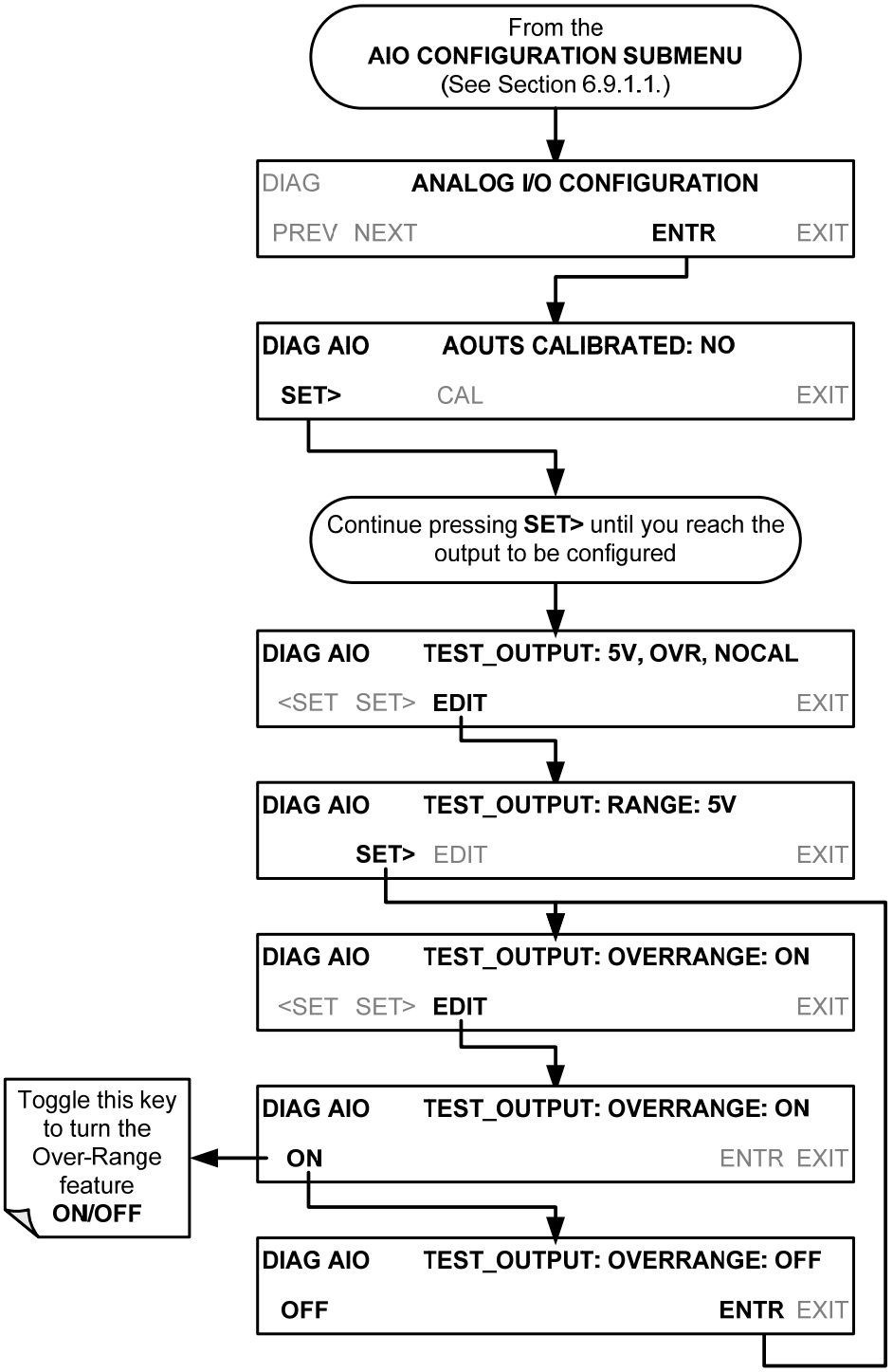
To change the output range, press,



6.9.1.4. Turning the TEST CHANNEL Over-Range Feature ON/OFF

In its default configuration a ± 5% over-range is available on each of the M703E's **TEST CHANNEL** output. This over-range can be disabled if your recording device is sensitive to excess voltage or current.

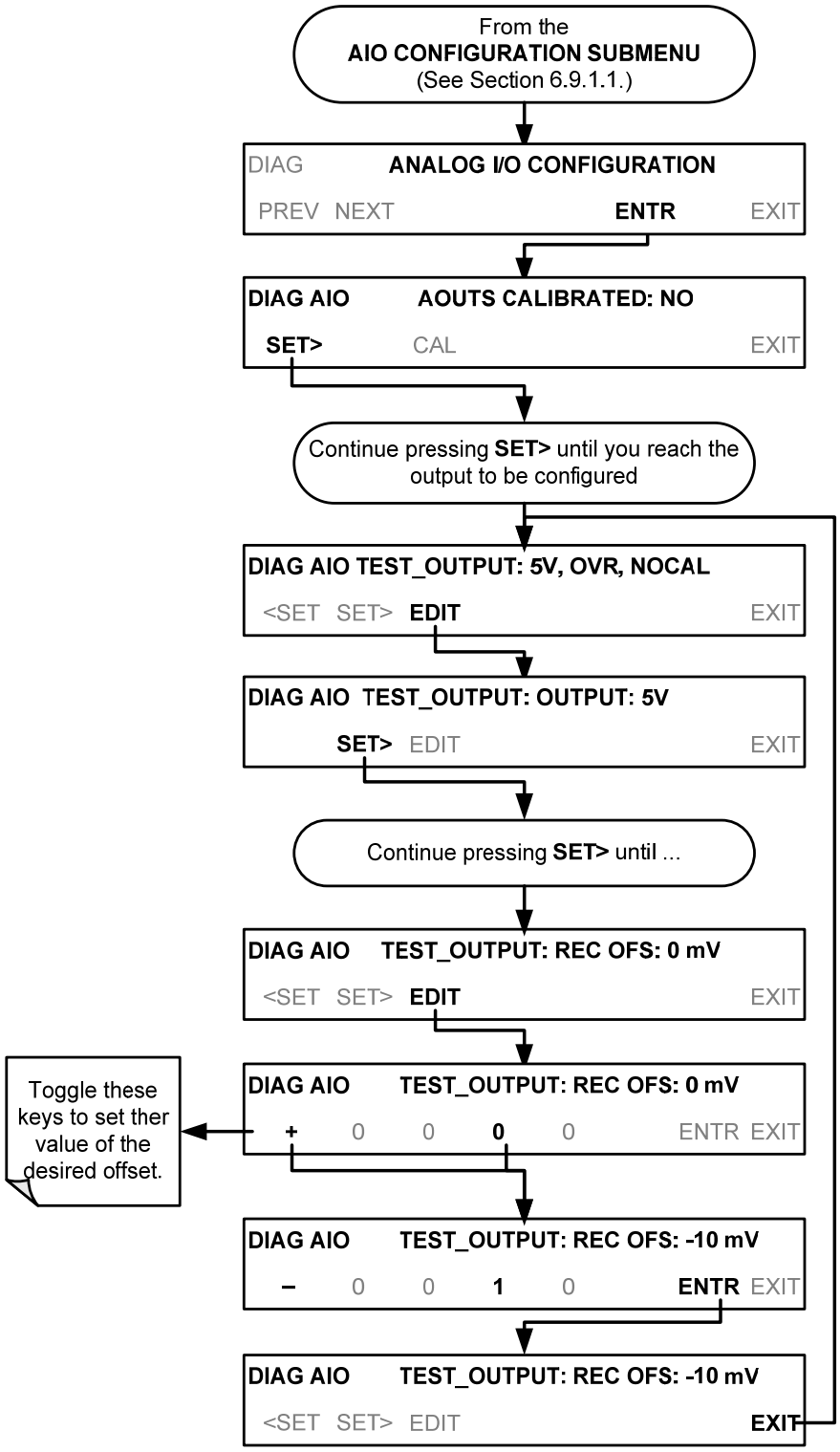
To turn the over-range feature on or off, press:


From the
AIO CONFIGURATION SUBMENU
(See Section 6.9.1.1.)
DIAG ANALOG I/O CONFIGURATION
PREV NEXT ENTR EXIT
DIAG AIO AOUTS CALIBRATED: NO
SET> CAL EXIT
Continue pressing SET> until you reach the output to be configured
DIAG AIO TEST_OUTPUT: 5V, OVR, NOCAL
<SET SET> EDIT EXIT
DIAG AIO TEST_OUTPUT: RANGE: 5V
SET> EDIT EXIT
DIAG AIO TEST_OUTPUT: OVERRANGE: ON
<SET SET> EDIT EXIT
DIAG AIO TEST_OUTPUT: OVERRANGE: ON
ON ENTR EXIT
Toggle this key to turn the Over-Range feature ON/OFF
DIAG AIO TEST_OUTPUT: OVERRANGE: OFF
OFF ENTR EXIT

6.9.1.5. Adding a Recorder Offset to the TEST CHANNEL

Some analog signal recorders require that the zero signal be significantly different from the baseline of the recorder in order to record slightly negative readings from noise around the zero point. This can be achieved in the M703E by defining a zero offset, a small voltage (e.g., 10% of span).

To add a zero offset to a specific analog output channel, press:


From the
AIO CONFIGURATION SUBMENU
(See Section 6.9.1.1.)
DIAG ANALOG I/O CONFIGURATION
PREV NEXT ENTR EXIT
DIAG AIO AOUTS CALIBRATED: NO
SET> CAL EXIT
Continue pressing SET> until you reach the output to be configured
DIAG AIO TEST_OUTPUT: 5V, OVR, NOCAL
<SET SET> EDIT EXIT
DIAG AIO TEST_OUTPUT: OUTPUT: 5V
SET> EDIT EXIT
Continue pressing SET> until ...
DIAG AIO TEST_OUTPUT: REC OFS: 0 mV
<SET SET> EDIT EXIT
DIAG AIO TEST_OUTPUT: REC OFS: 0 mV
+ 0 0 0 0 ENTR EXIT
Toggle these keys to set ther value of the desired offset.
DIAG AIO TEST_OUTPUT: REC OFS: -10 mV
– 0 0 1 0 ENTR EXIT
DIAG AIO TEST_OUTPUT: REC OFS: -10 mV
<SET SET> EDIT EXIT

6.9.2. TEST CHANNEL CALIBRATION

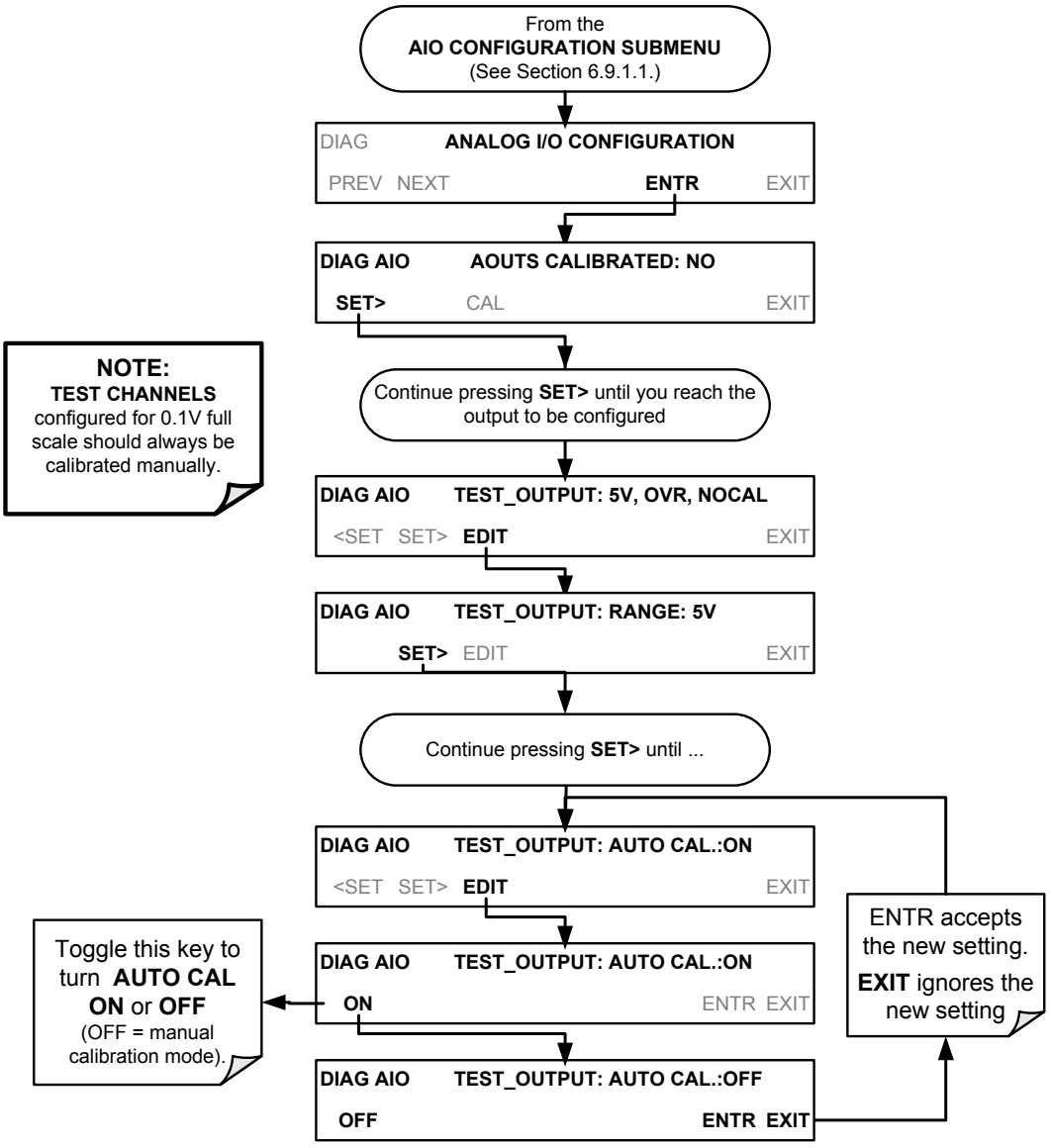
TEST CHANNEL calibration needs to be carried out on first startup of the analyzer (performed in the factory as part of the configuration process) or whenever re-calibration is required. The analog outputs can be calibrated automatically or adjusted manually.

During automatic calibration, the analyzer tells the output circuitry to generate a zero mV signal and high-scale point signal (usually about 90% of chosen analog signal scale) then measures actual signal of the output. Any error at zero or high-scale is corrected with a slope and offset.

Automatic calibration can be performed via the **AOUTS CALIBRATION** command, or by using the **CAL** button located inside **TEST_CHANNEL** submenu. By default, the analyzer is configured so that calibration of **TEST CHANNEL** can be initiated with the **AOUTS CALIBRATION** command.

6.9.2.1. Enabling or disabling the TEST CHANNEL Auto-Cal Feature

To enable or disable the Auto-Cal feature for the **TEST CHANNEL**, press.


From the
AIO CONFIGURATION SUBMENU
(See Section 6.9.1.1.)
DIAG ANALOG I/O CONFIGURATION
PREV NEXT ENTR EXIT
DIAG AIO AOUTS CALIBRATED: NO
SET> CAL EXIT
NOTE:
TEST CHANNELS configured for 0.1V full scale should always be calibrated manually.
Continue pressing SET> until you reach the output to be configured
DIAG AIO TEST_OUTPUT: 5V, OVR, NOCAL
<SET SET> EDIT EXIT
DIAG AIO TEST_OUTPUT: RANGE: 5V
SET> EDIT EXIT
Continue pressing SET> until ...
DIAG AIO TEST_OUTPUT: AUTO CAL.:ON
<SET SET> EDIT EXIT
DIAG AIO TEST_OUTPUT: AUTO CAL.:ON
ON ENTR EXIT
Toggle this key to turn AUTO CAL ON or OFF (OFF = manual calibration mode).
DIAG AIO TEST_OUTPUT: AUTO CAL.:OFF
OFF ENTR EXIT
ENTR accepts the new setting.
EXIT ignores the new setting

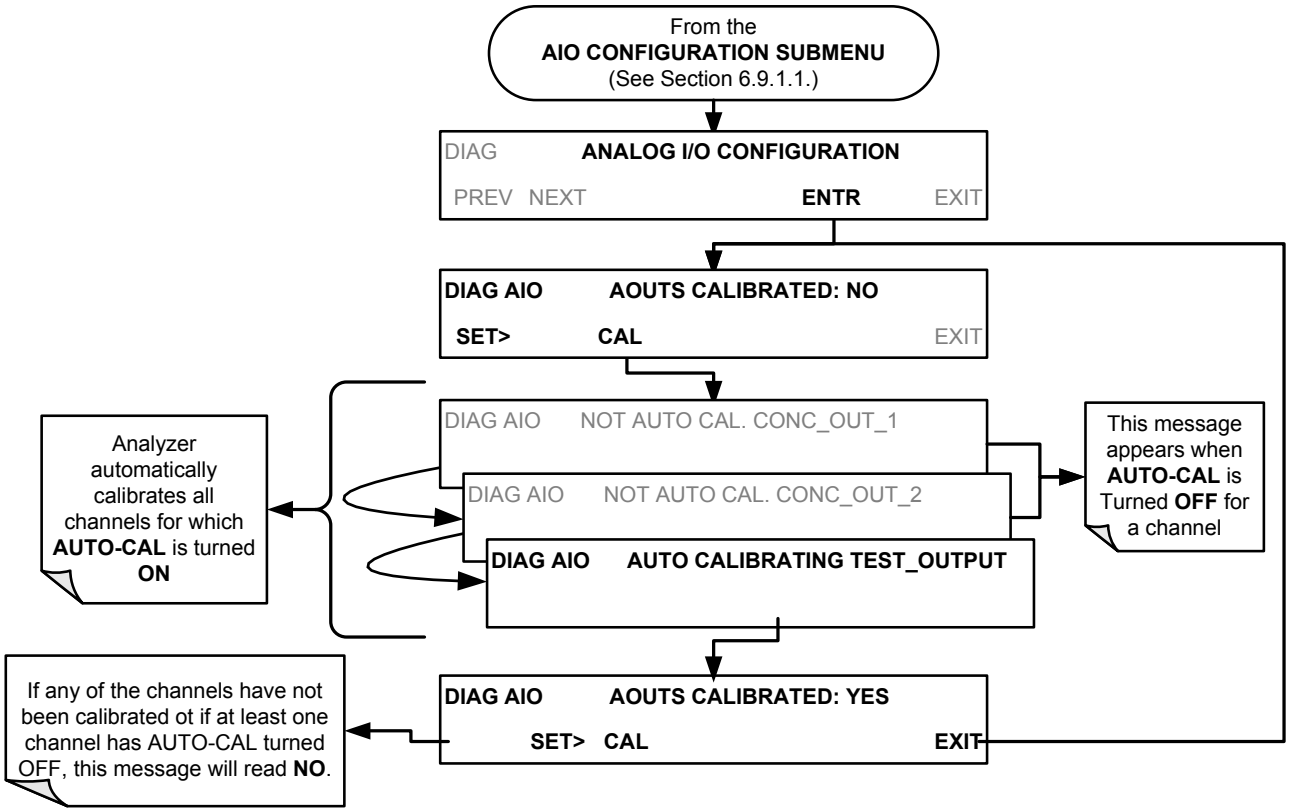
6.9.2.2. Automatic TEST CHANNEL Calibration

To calibrate the outputs as a group with the **AOUTS CALIBRATION** command, press:

NOTE

Before performing this procedure, make sure that the AUTO CAL feature is turned OFF for CONC_OUT_1 and CONC_OUT_2,

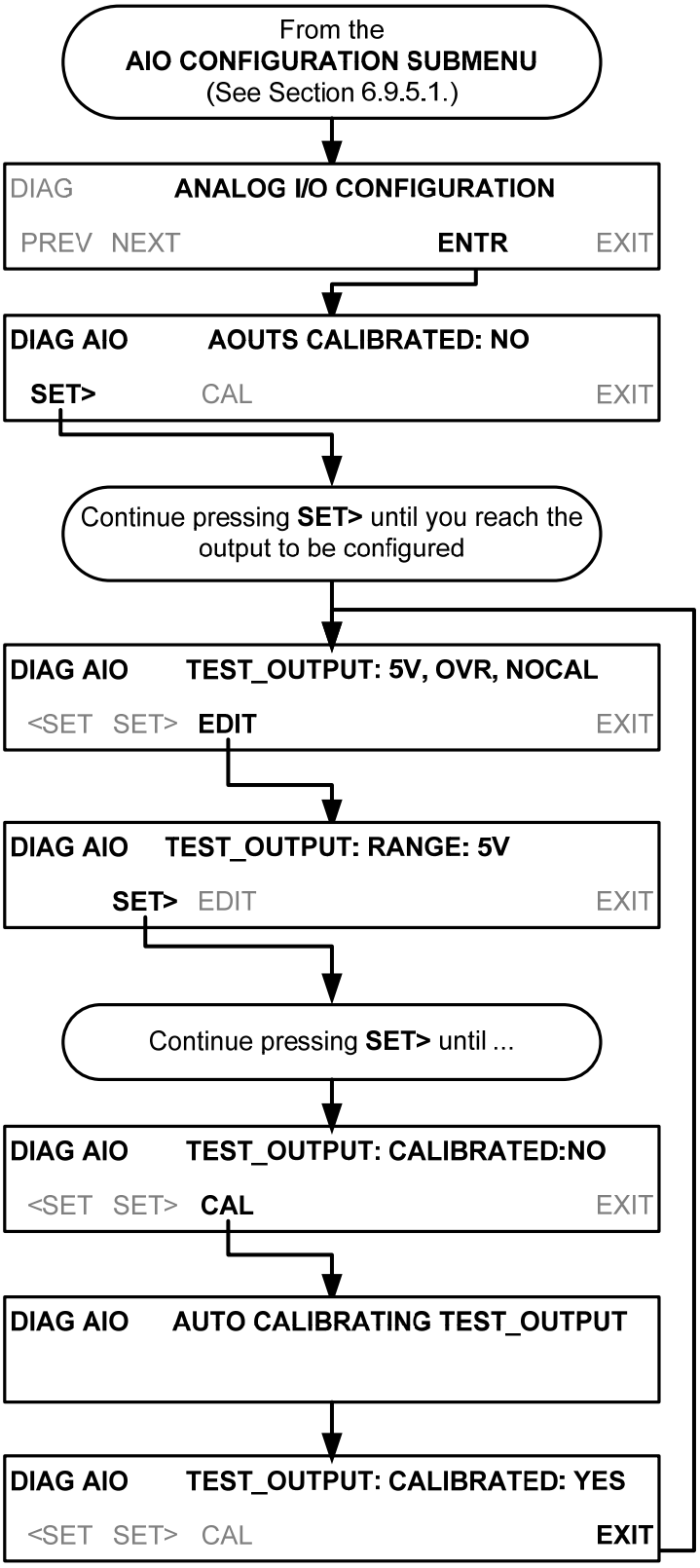
Make sure that the AUTO CAL feature is turned ON for the TEST CHANNEL (See Section 6.9.2.1)


From the
AIO CONFIGURATION SUBMENU
(See Section 6.9.1.1.)
DIAG ANALOG I/O CONFIGURATION
PREV NEXT ENTR EXIT
DIAG AIO AOUTS CALIBRATED: NO
SET> CAL EXIT
DIAG AIO NOT AUTO CAL. CONC_OUT_1
DIAG AIO NOT AUTO CAL. CONC_OUT_2
DIAG AIO AUTO CALIBRATING TEST_OUTPUT
Analyzer automatically calibrates all channels for which AUTO-CAL is turned ON
This message appears when AUTO-CAL is Turned OFF for a channel
DIAG AIO AOUTS CALIBRATED: YES
SET> CAL EXIT
If any of the channels have not been calibrated ot if at least one channel has AUTO-CAL turned OFF, this message will read NO.

NOTE:

Manual calibration should be used for the 0.1V range or in cases where the outputs must be closely matched to the characteristics of the recording device.

To initiate an automatic calibration from inside the **TEST CHANNEL** submenu, press:


From the
AIO CONFIGURATION SUBMENU
(See Section 6.9.5.1.)
DIAG ANALOG I/O CONFIGURATION
PREV NEXT ENTR EXIT
DIAG AIO AOUTS CALIBRATED: NO
SET> CAL EXIT
Continue pressing SET> until you reach the output to be configured
DIAG AIO TEST_OUTPUT: 5V, OVR, NOCAL
<SET SET> EDIT EXIT
DIAG AIO TEST_OUTPUT: RANGE: 5V
SET> EDIT EXIT
Continue pressing SET> until ...
DIAG AIO TEST_OUTPUT: CALIBRATED:NO
<SET SET> CAL EXIT
DIAG AIO AUTO CALIBRATING TEST_OUTPUT
DIAG AIO TEST_OUTPUT: CALIBRATED: YES
<SET SET> CAL EXIT

6.9.2.3. Manual Calibration of the TEST CHANNEL configured for Voltage Ranges

For highest accuracy, the voltages of the analog outputs can be manually calibrated.

NOTE:

The menu for manually adjusting the analog output signal level will only appear if the AUTO-CAL feature is turned off for the channel being adjusted (see Section6.9.2.1)

Calibration is performed with a voltmeter connected across the output terminals (See Figure 6-2) and by changing the actual output signal level using the front panel keys in 100, 10 or 1 count increments.

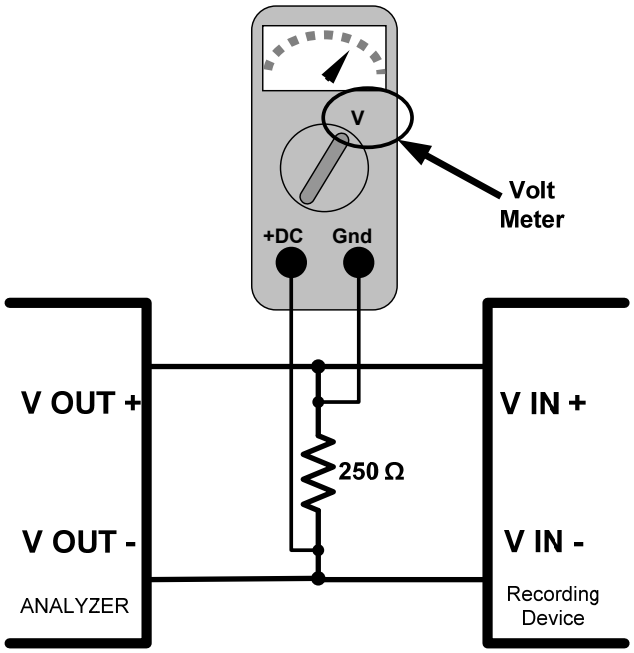
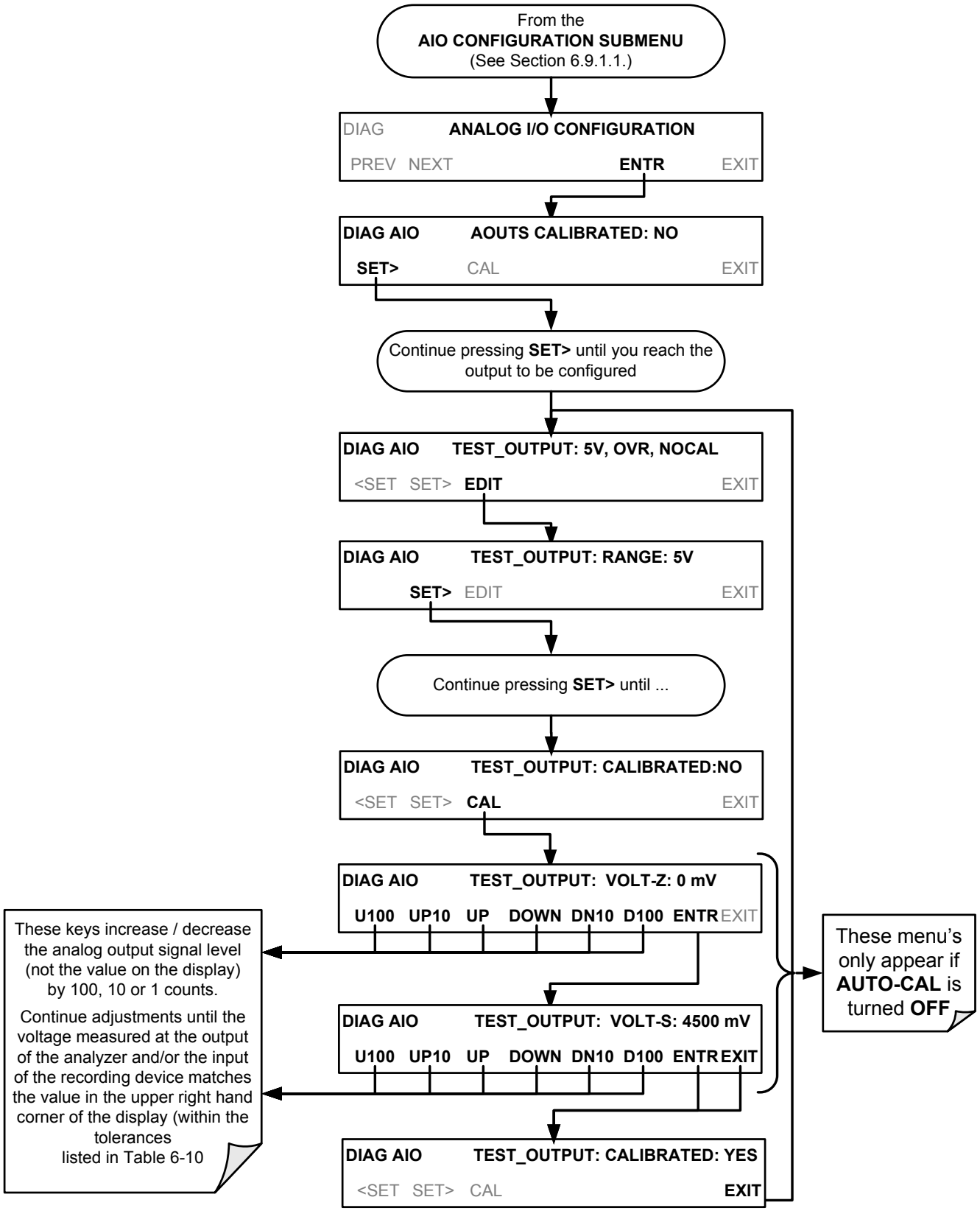


Figure 6-3: Setup for Calibrating the TEST CHANNEL

Table 6-10: Voltage Tolerances for the TEST CHANNEL Calibration

FULL SCALE	ZERO TOLERANCE	SPAN VOLTAGE	SPAN TOLERANCE	MINIMUM ADJUSTMENT (1 count)
0.1 VDC	±0.0005V	90 mV	±0.001V	0.02 mV
1 VDC	±0.001V	900 mV	±0.001V	0.24 mV
5 VDC	±0.002V	4500 mV	±0.003V	1.22 mV
10 VDC	±0.004V	4500 mV	±0.006V	2.44 mV

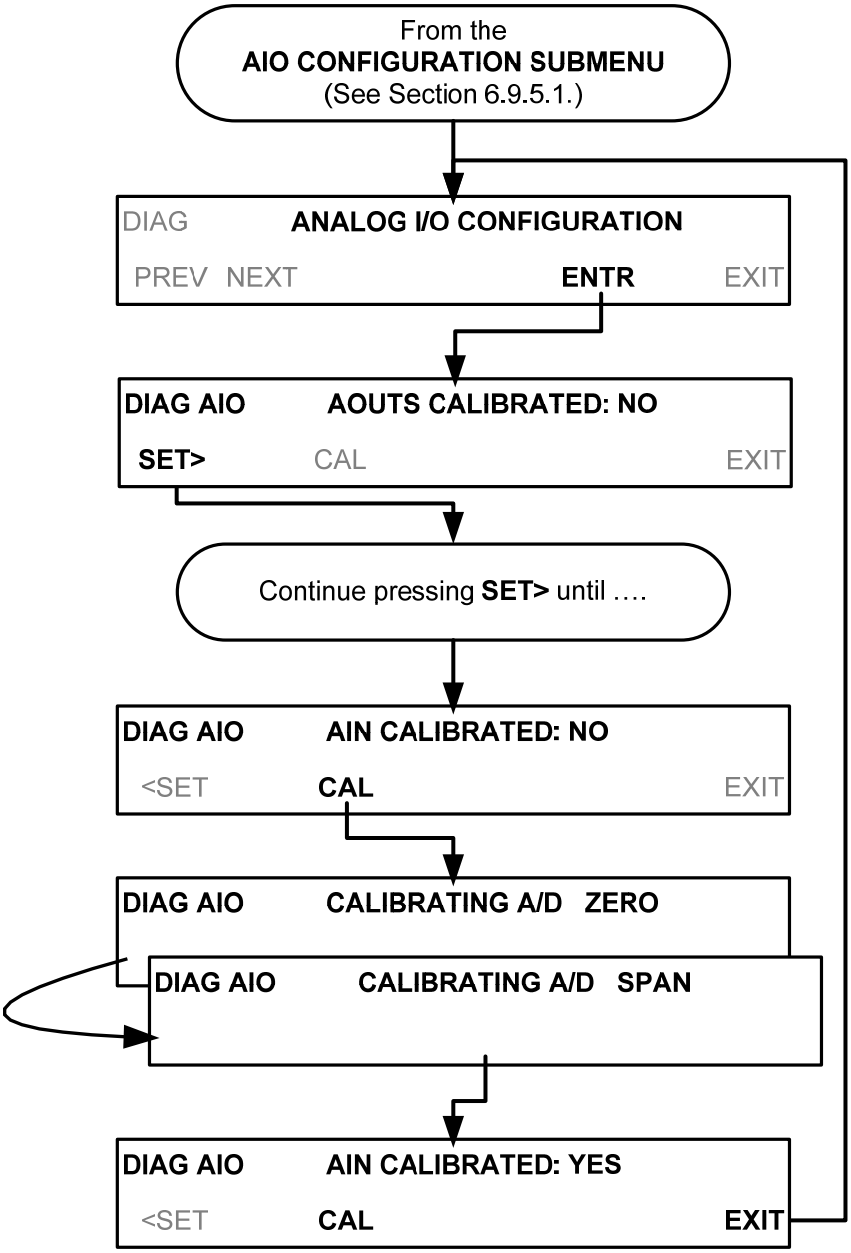
To adjust the signal levels of an analog output channel manually, press:


From the
AIO CONFIGURATION SUBMENU
(See Section 6.9.1.1.)
DIAG ANALOG I/O CONFIGURATION
PREV NEXT ENTR EXIT
DIAG AIO AOUTS CALIBRATED: NO
SET> CAL EXIT
Continue pressing SET> until you reach the output to be configured
DIAG AIO TEST_OUTPUT: 5V, OVR, NOCAL
<SET SET> EDIT EXIT
DIAG AIO TEST_OUTPUT: RANGE: 5V
SET> EDIT EXIT
Continue pressing SET> until ...
DIAG AIO TEST_OUTPUT: CALIBRATED:NO
<SET SET> CAL EXIT
DIAG AIO TEST_OUTPUT: VOLT-Z: 0 mV
U100 UP10 UP DOWN DN10 D100 ENTR EXIT
DIAG AIO TEST_OUTPUT: VOLT-S: 4500 mV
U100 UP10 UP DOWN DN10 D100 ENTR EXIT
DIAG AIO TEST_OUTPUT: CALIBRATED: YES
<SET SET> CAL EXIT
These keys increase / decrease the analog output signal level (not the value on the display) by 100, 10 or 1 counts.
Continue adjustments until the voltage measured at the output of the analyzer and/or the input of the recording device matches the value in the upper right hand corner of the display (within the tolerances listed in Table 6-10
These menu's only appear if AUTO-CAL is turned OFF

6.9.3. AIN CALIBRATION

This is the sub-menu calibrates the analyzer's A-to-D conversion circuitry. This calibration should only be necessary after major repair such as a replacement of CPU, motherboard or power supplies.

To perform an **AIN CALIBRATION**, press:



6.10. SETUP → MORE → VARS: INTERNAL VARIABLES (VARS)

The M703E has several-user adjustable software variables, which define certain operational parameters. Usually, these variables are automatically set by the instrument's firmware, but can be manually re-defined using the VARS menu.

The following table lists all variables that are available within the 818 password protected level. See Appendix A2 for a detailed listing of all of the M703E variables that are accessible through the remote interface.

Table 6-11: Variable Names (VARS)

NO.	VARIABLE	DESCRIPTION	ALLOWED VALUES	DEFAULT VALUES
0	*PHOTO_LAMP[1,2]*	*Sets the photometer lamp temperature set point and warning limits.*	*0ºC and 100ºC*	*58ºC Warning limits 56ºC - 61ºC*
1	*O3_GEN LAMP[1,2]*	*Sets the O_3 generator lamp temperature set point and warning limits.*	*0ºC and 100ºC*	*48ºC Warning limits 43ºC - 53ºC*
2	**O3_CONC_RANGE**	Set the upper span point of the O_3 concentration range for TEST CHANNEL analog signal **O3_PHOTO_CONC**.	0.1–20000 ppb	500 ppb
3	**O3_PHOTO_BENCH_ONLY[2]**	O_3 bench control flag. • ON turns on the photometer pump and switches measure/reference valve only when the O_3 mode is set for BNCH (See Section 3.4.5).	ON/OFF	OFF
4	**ZA_PUMP_ENAB[2]**	Internal zero air pump control. ON turns on internal zero air pump when generating ozone.	ON/OFF	ON
5	*STD_TEMP[1]*	*Sets the standard Temperature used in calculating O_3 flow rates and concentrations.*	*0ºC and 100ºC*	*25ºC*
6	*STD PRESSURE[1]*	*Sets the standard pressure used in calculating O_3 flow rates and concentrations.*	*29.92 in-Hg-A*	*15.00 – 50 .00 in-Hg-A*
7	**CLOCK_ADJ**	Adjusts the speed of the analyzer's clock. Choose the + sign if the clock is too slow, choose the - sign if the clock is too fast (See Section 6.7.2).	-60 to +60 s/day Default=0	0

[1] **DO NOT ADJUST OR CHANGE** these values unless instructed to by Teledyne Instruments' customer service personnel.

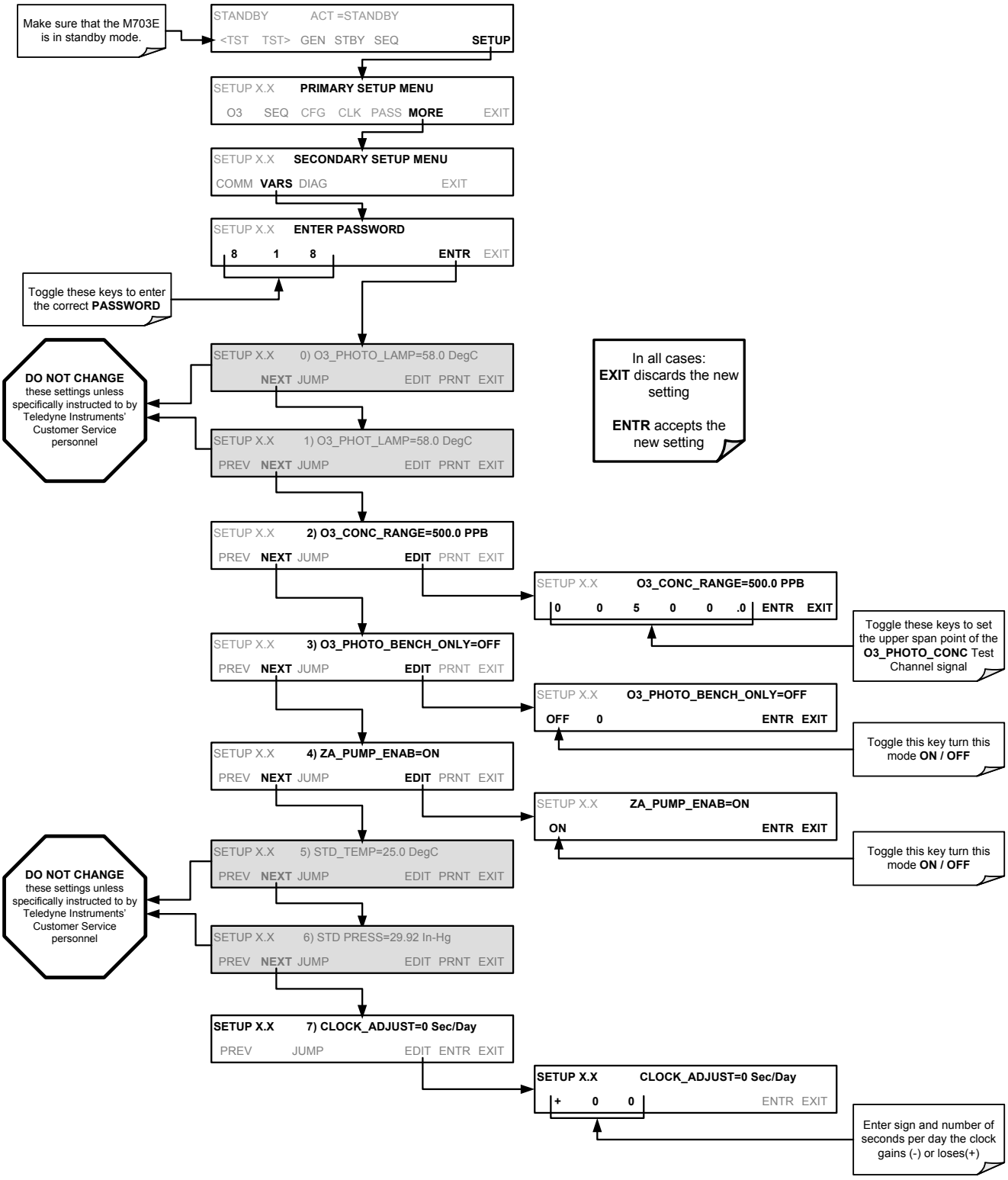
[2] Only available in calibrators with O_3 photometer and generator options installed.

NOTE:

There is a 2-second latency period between when a VARS value is changed and the new value is stored into the analyzer's memory.

DO NOT turn the analyzer off during this period or the new setting will be lost.

To access and navigate the VARS menu, use the following key sequence:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DO NOT CHANGE these settings unless specifically instructed to by Teledyne Instruments' Customer Service personnel
SETUP X.X 0) O3_PHOTO_LAMP=58.0 DegC
NEXT JUMP EDIT PRNT EXIT
SETUP X.X 1) O3_PHOT_LAMP=58.0 DegC
PREV NEXT JUMP EDIT PRNT EXIT
In all cases:
EXIT discards the new setting
ENTR accepts the new setting
SETUP X.X 2) O3_CONC_RANGE=500.0 PPB
PREV NEXT JUMP EDIT PRNT EXIT
SETUP X.X O3_CONC_RANGE=500.0 PPB
0 0 5 0 0 .0 ENTR EXIT
Toggle these keys to set the upper span point of the O3_PHOTO_CONC Test Channel signal
SETUP X.X 3) O3_PHOTO_BENCH_ONLY=OFF
PREV NEXT JUMP EDIT PRNT EXIT
SETUP X.X O3_PHOTO_BENCH_ONLY=OFF
OFF 0 ENTR EXIT
Toggle this key turn this mode ON / OFF
SETUP X.X 4) ZA_PUMP_ENAB=ON
PREV NEXT JUMP EDIT PRNT EXIT
SETUP X.X ZA_PUMP_ENAB=ON
ON ENTR EXIT
Toggle this key turn this mode ON / OFF
DO NOT CHANGE these settings unless specifically instructed to by Teledyne Instruments' Customer Service personnel
SETUP X.X 5) STD_TEMP=25.0 DegC
PREV NEXT JUMP EDIT PRNT EXIT
SETUP X.X 6) STD PRESS=29.92 In-Hg
PREV NEXT JUMP EDIT PRNT EXIT
SETUP X.X 7) CLOCK_ADJUST=0 Sec/Day
PREV JUMP EDIT ENTR EXIT
SETUP X.X CLOCK_ADJUST=0 Sec/Day
+ 0 0 ENTR EXIT
Enter sign and number of seconds per day the clock gains (-) or loses(+)

6.11. OPERATING THE M703E CALIBRATOR AS AN O_3 PHOTOMETER

The M703E can easily be configured to measure an external source of ozone.

6.11.1. SET UP FOR OPERATING THE M703E AS AN O_3 PHOTOMETER

To convert the M703E from an O_3 calibrator to and O_3 photometer:

1. Remove the two loop-back tubing assemblies on the rear panel connected to the 'PHOTO IN' and 'PHOTO REF IN' fittings.
2. Connect the ozone source to be measured to the 'PHOTO IN' fitting.
   - This gas must be supplied at atmospheric pressure.
3. Connect a reference gas (Zero Air) for the photometer to the 'PHOTO REF IN.'
   - This gas must be supplied at atmospheric pressure. To avoid interference effects, the reference gas should be from the same source than is being used to feed the ozone generator that is being assayed.

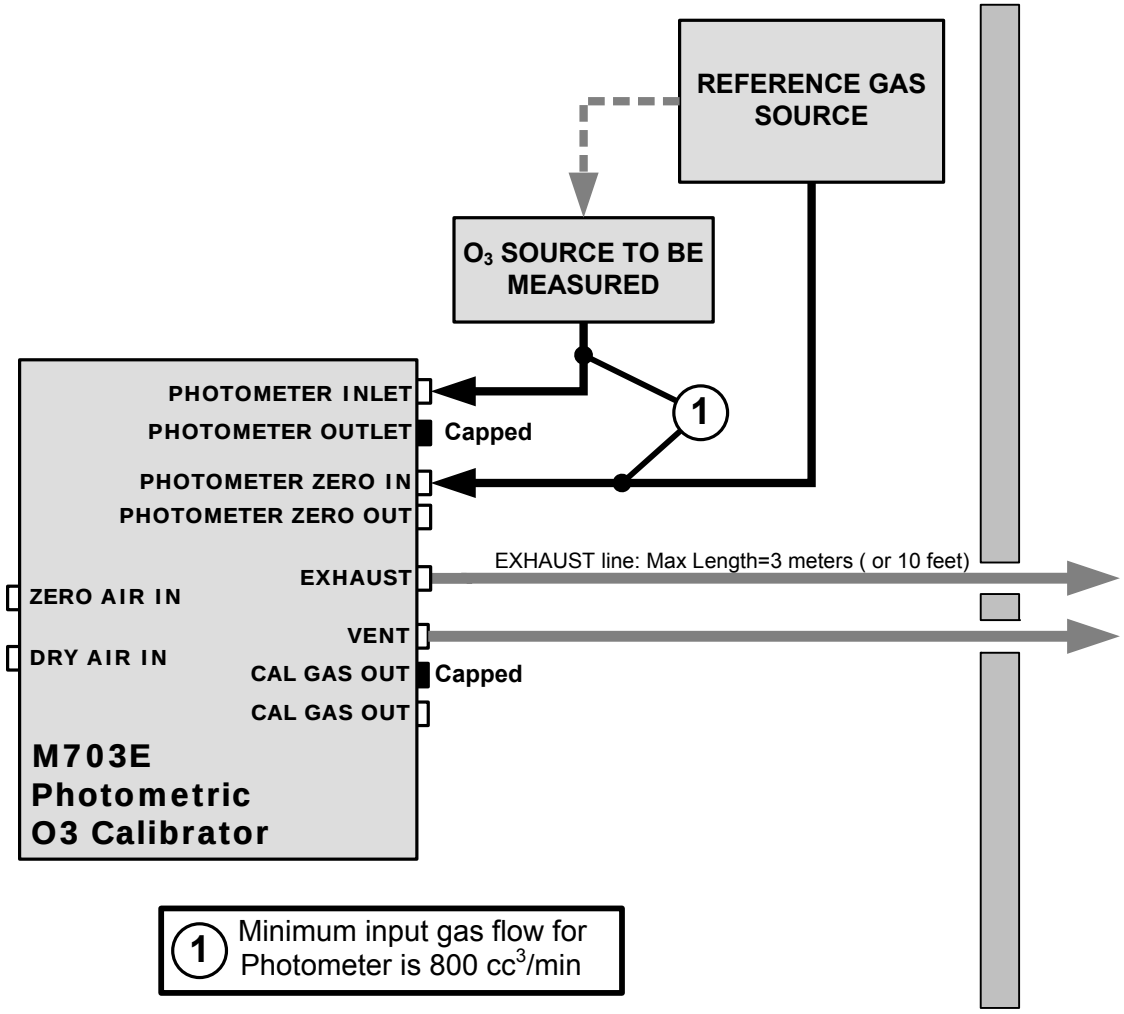
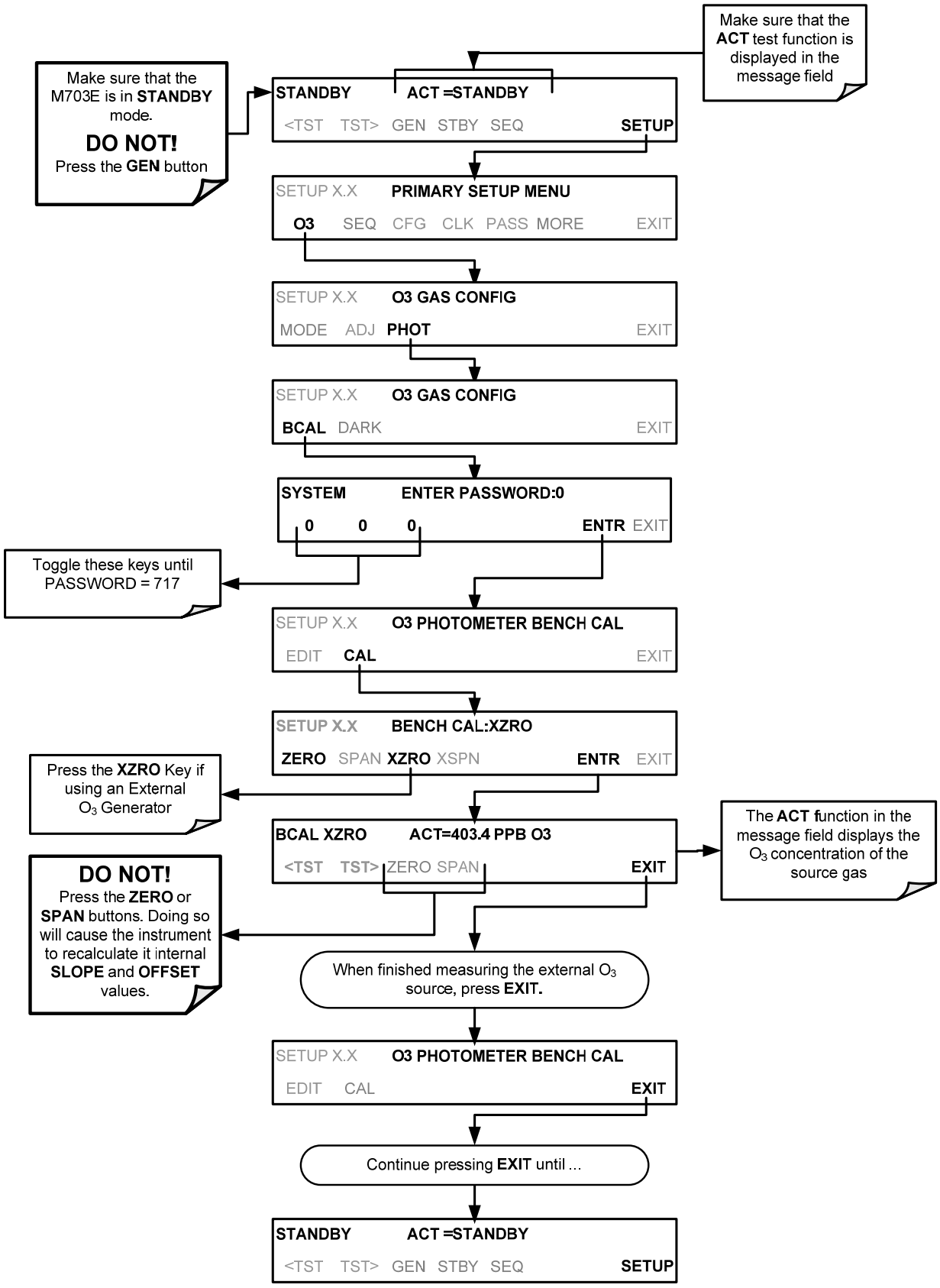


Figure 6-4: Set up for Using the M703E to Measure an External O_3 Source

To use the M703E as a photometer, press:


Make sure that the ACT test function is displayed in the message field
Make sure that the M703E is in STANDBY mode.
DO NOT!
Press the GEN button
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X O3 GAS CONFIG
MODE ADJ PHOT EXIT
SETUP X.X O3 GAS CONFIG
BCAL DARK EXIT
SYSTEM ENTER PASSWORD:0
0 0 0 ENTR EXIT
Toggle these keys until PASSWORD = 717
SETUP X.X O3 PHOTOMETER BENCH CAL
EDIT CAL EXIT
SETUP X.X BENCH CAL:XZRO
ZERO SPAN XZRO XSPN ENTR EXIT
Press the XZRO Key if using an External O3 Generator
BCAL XZRO ACT=403.4 PPB O3
<TST TST> ZERO SPAN EXIT
The ACT function in the message field displays the O3 concentration of the source gas
DO NOT!
Press the ZERO or SPAN buttons. Doing so will cause the instrument to recalculate it internal SLOPE and OFFSET values.
When finished measuring the external O3 source, press EXIT.
SETUP X.X O3 PHOTOMETER BENCH CAL
EDIT CAL EXIT
Continue pressing EXIT until ...
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP

6.12. SETUP → LVL: SETTING UP AND USING LEADS (DASIBI) OPERATING LEVELS

6.12.1. GENERAL INFORMATION ABOUT LEADS LEVELS

The M703E calibrator can be equipped with a version of firmware that includes support for LEADS, a data collection and analysis system LEADS specifically designed for handling meteorological and environmental data particularly when there is a need to integrate data and control instrumentation from several different manufacturers. When an M703E calibrator is equipped with the optional LEADS software is used in conjunction with data loggers located central data analysis facility is possible to collect and buffer data between the various calibrators, analyzers and metrological equipment remotely located at an air monitoring station.

Because LEADS was originally developed for use with TNRCC using Dasibi 5008 calibrators, the LEADS version of the M703E includes support for Dasibi "Dot" serial data commands and operational "LEVEL's".

NOTE

For more information on the LEADS system, please go to http://www.meteostar.com/.

6.12.2. DOT COMMANDS

The Dasibi "Dot" commands form a text-based (ASCII) data protocol that is transmitted between a control computer (XENO data logger in this case) and a calibrator or ambient gas analyzer over an RS-232 connection. The details of the protocol are beyond the scope of this document, but in its simplest form the protocol is based on a two or three digit integer preceded by a control-A and a period (.) and then followed by a "!" and a two digit checksum.

EXAMPLE:

^A.xxx!nn

For further information on dot commands, please contact T-API customer service.

An M703E equipped with LEADS software can be simultaneously operated over the same COM port using standard Teledyne Instruments' serial data commands and is compatible with APIcom versions 3.7.3 and later which include an added feature that allows a user to edit, upload and download level tables.

6.12.3. LEVELS

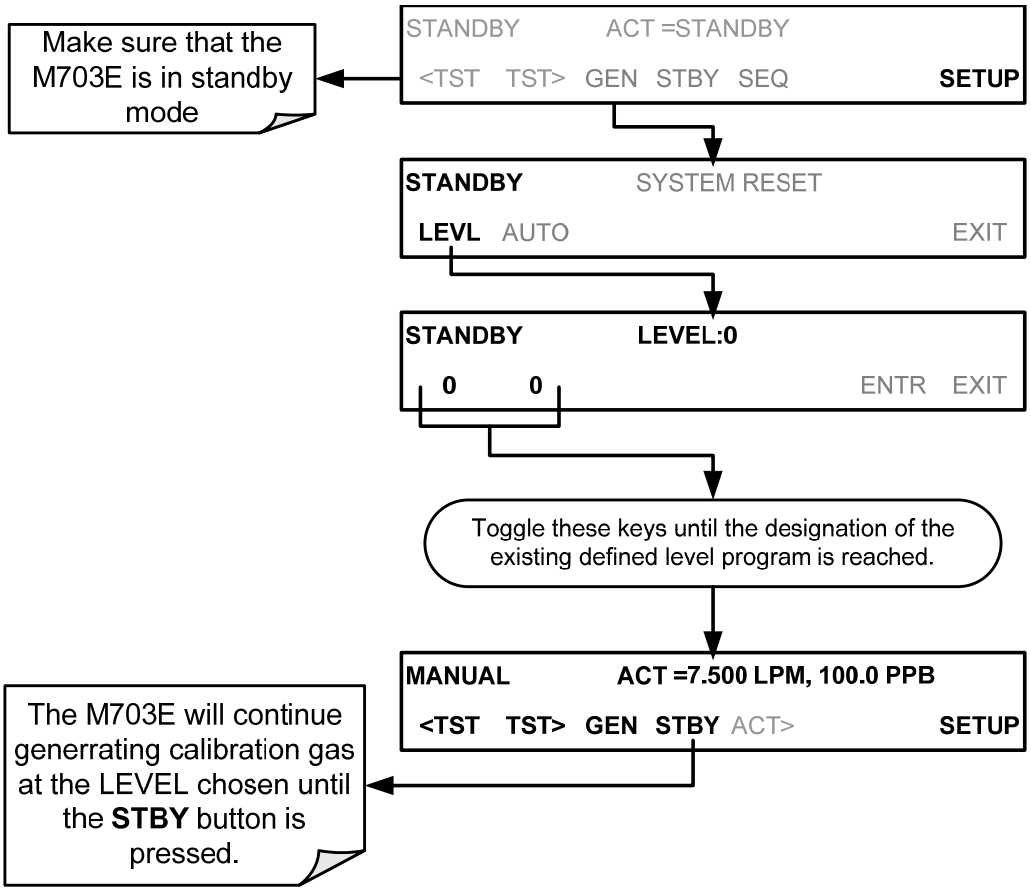
A **LEVEL** is a combination of several parameters:

- An ID number for the LEVEL
- An action, (e.g. GENERATE, STANDBY)
  - A target concentration value
  - An output flow rate (if applicable)
  - Configuration for one or both of two status output blocks.

Up to twenty levels can be defined and used with the M703E using a range of ID numbers from 0-98. Level 99 is reserved for standby. Are not time based and do not include characteristics such as start time or duration, therefore a single LEVEL can not switch between different concentration levels and flow rates. Separate flow and concentration outputs must be programmed into separate LEVELs which are then individually started and stopped either by an operator at the calibrator's front panel or through a serial data operation over the RS-232 or Ethernet ports.

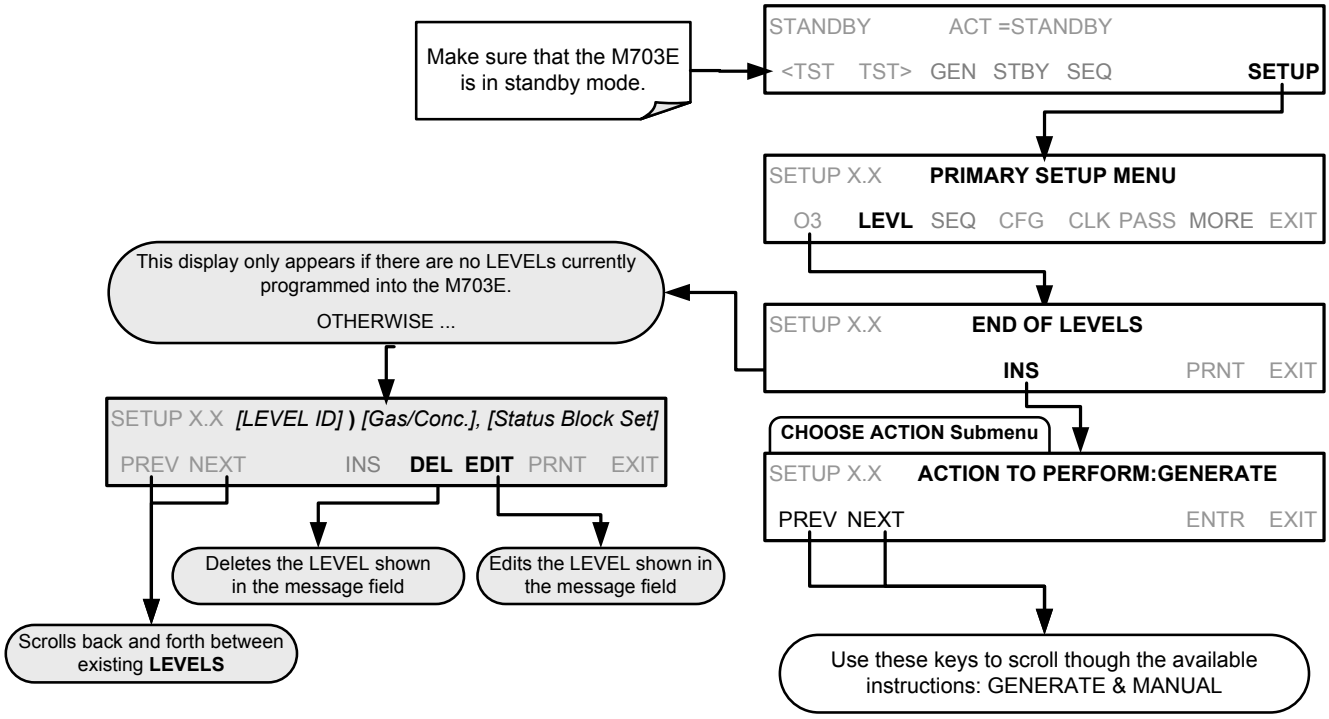
6.12.4. ACTIVATING AN EXISTING LEVEL

To activate an existing defined **LEVEL**, press:


Make sure that the M703E is in standby mode
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
STANDBY SYSTEM RESET
LEVL AUTO EXIT
STANDBY LEVEL:0
0 0 ENTR EXIT
Toggle these keys until the designation of the existing defined level program is reached.
MANUAL ACT =7.500 LPM, 100.0 PPB
<TST TST> GEN STBY ACT> SETUP
The M703E will continue generrating calibration gas at the LEVEL chosen until the STBY button is pressed.

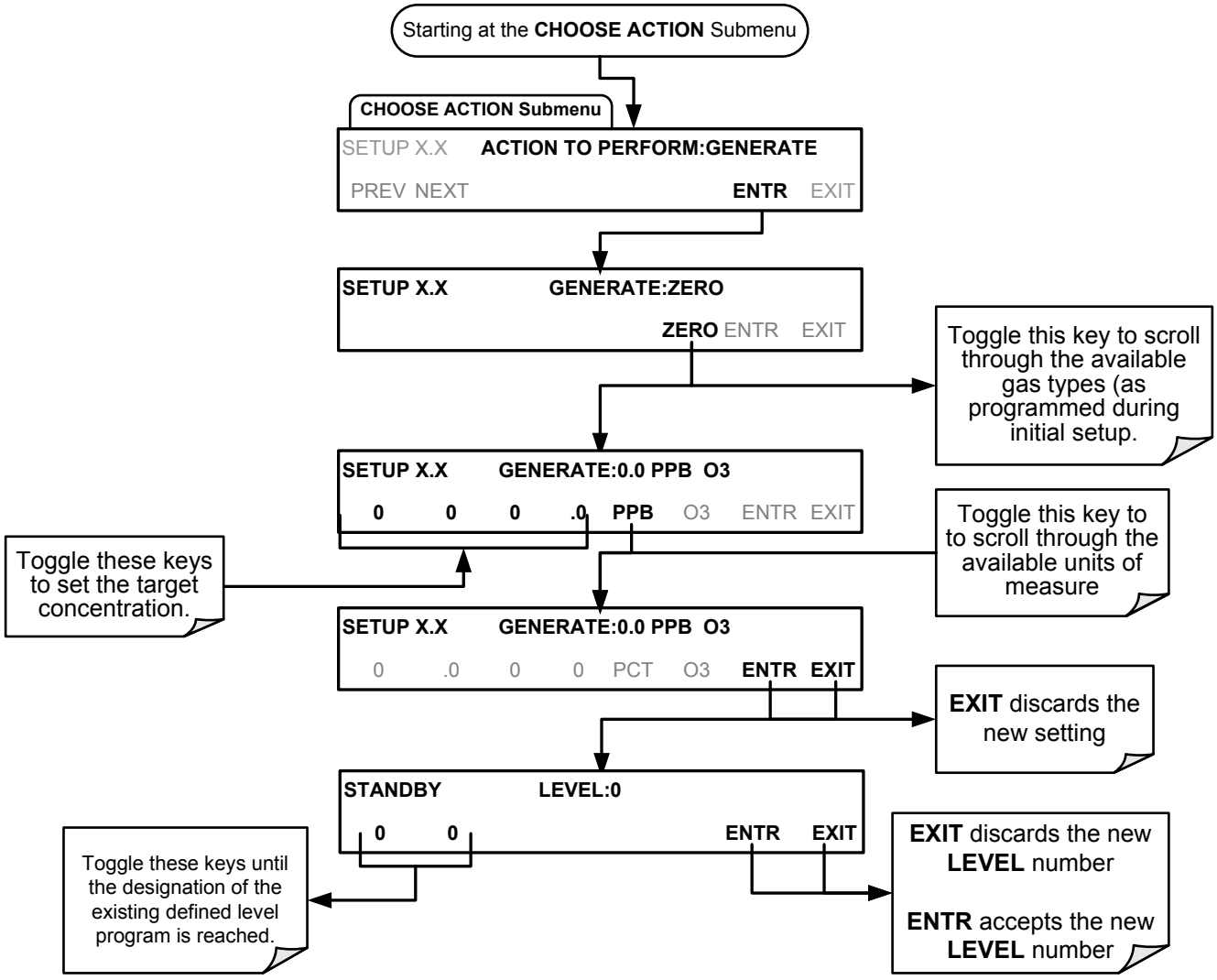
6.12.5. PROGRAMMING NEW LEVELS

To begin programming a new **LEVEL** find the **LVL** submenu by pressing:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 LEVL SEQ CFG CLK PASS MORE EXIT
This display only appears if there are no LEVELs currently programmed into the M703E.
OTHERWISE ...
SETUP X.X END OF LEVELS
INS PRNT EXIT
SETUP X.X [LEVEL ID]) [Gas/Conc.], [Status Block Set]
PREV NEXT INS DEL EDIT PRNT EXIT
CHOOSE ACTION Submenu
SETUP X.X ACTION TO PERFORM:GENERATE
PREV NEXT ENTR EXIT
Deletes the LEVEL shown in the message field
Edits the LEVEL shown in the message field
Scrolls back and forth between existing LEVELS
Use these keys to scroll though the available instructions: GENERATE & MANUAL

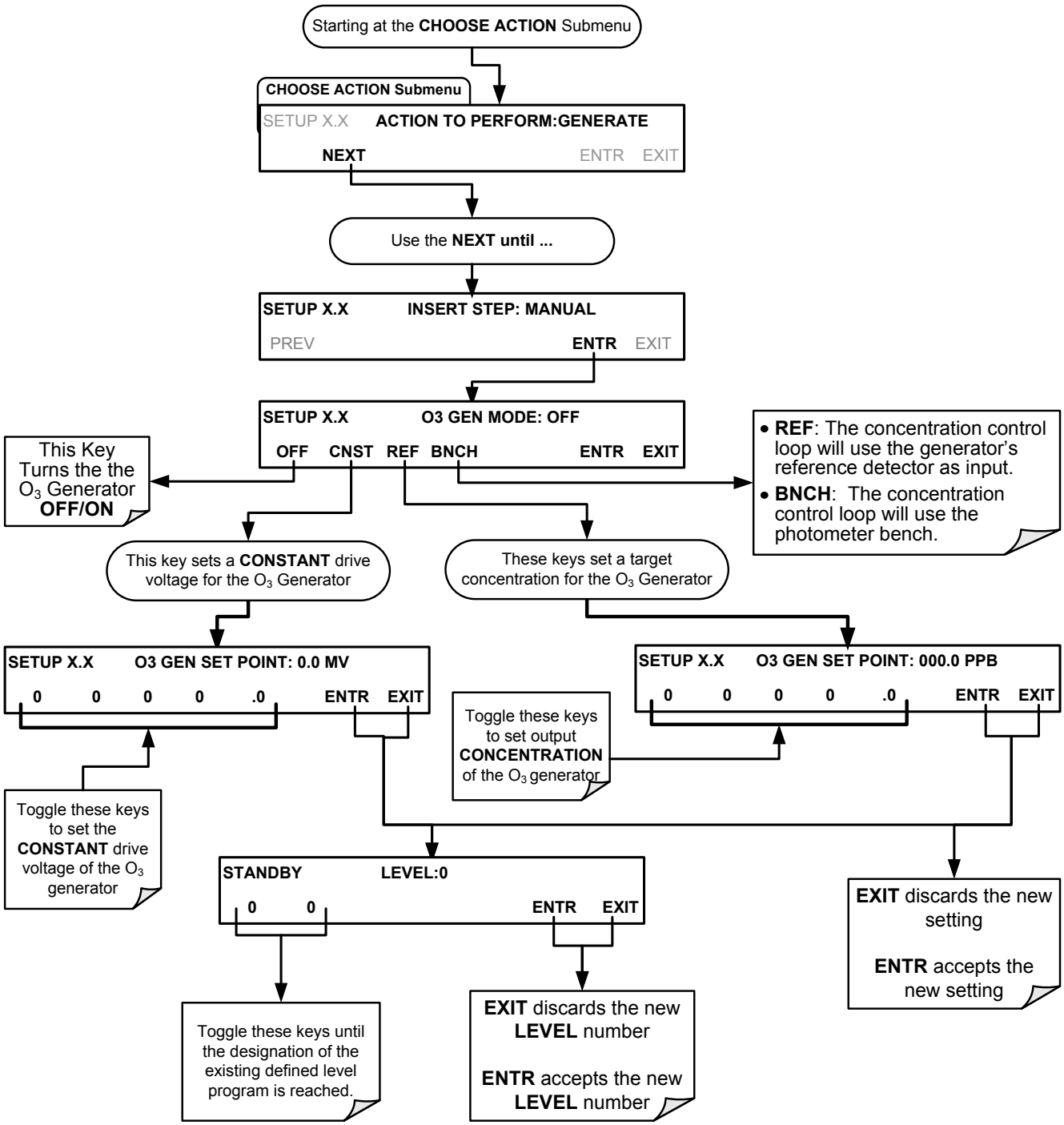
6.12.5.1. Creating a GENERATE LEVEL

To create a **LEVEL** using the M703E's **AUTO** generation function, press:


Starting at the **CHOOSE ACTION** Submenu
CHOOSE ACTION Submenu
SETUP X.X ACTION TO PERFORM:GENERATE
PREV NEXT ENTR EXIT
SETUP X.X GENERATE:ZERO
ZERO ENTR EXIT
Toggle this key to scroll through the available gas types (as programmed during initial setup.
SETUP X.X GENERATE:0.0 PPB O3
0 0 0 .0 PPB O3 ENTR EXIT
Toggle this key to to scroll through the available units of measure
Toggle these keys to set the target concentration.
SETUP X.X GENERATE:0.0 PPB O3
0 .0 0 0 PCT O3 ENTR EXIT
EXIT discards the new setting
STANDBY LEVEL:0
0 0 ENTR EXIT
Toggle these keys until the designation of the existing defined level program is reached.
EXIT discards the new LEVEL number
ENTR accepts the new LEVEL number

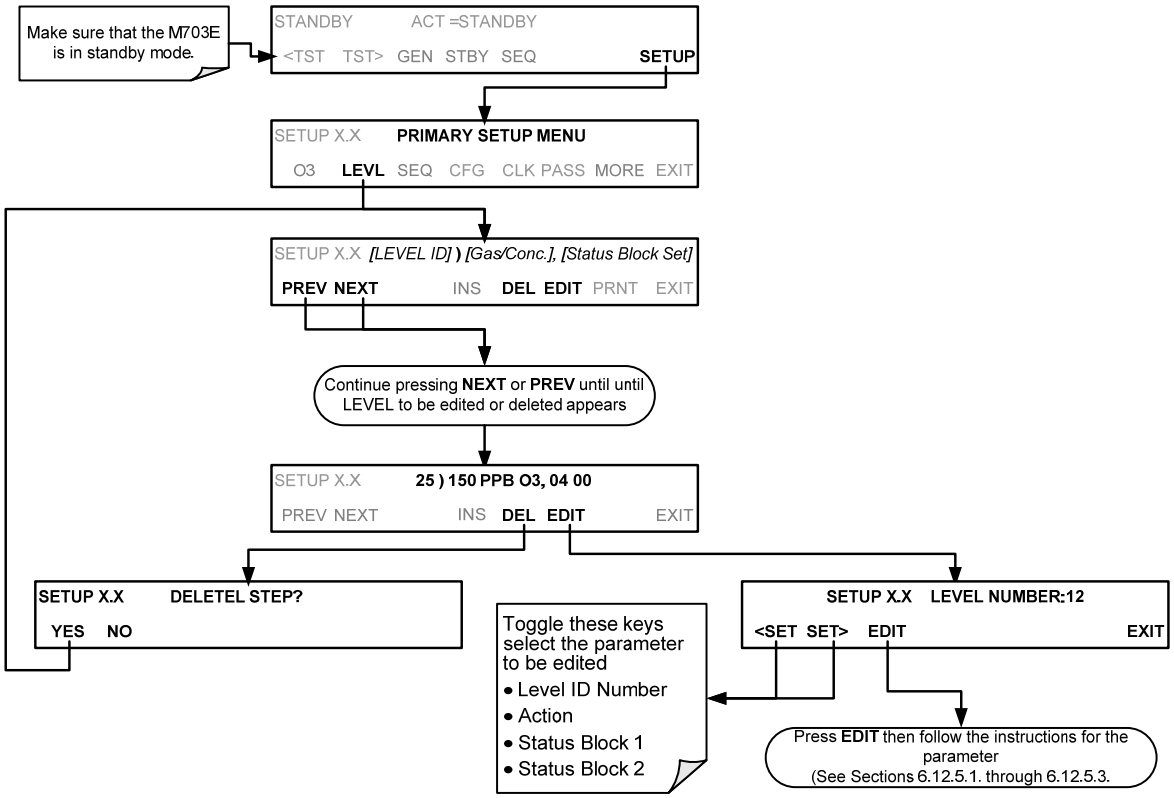
6.12.5.2. Creating a MANUAL LEVEL

To create a level using the M703E's **MANUAL** generation function, press:


Starting at the CHOOSE ACTION Submenu
CHOOSE ACTION Submenu
SETUP X.X ACTION TO PERFORM:GENERATE
NEXT ENTR EXIT
Use the NEXT until ...
SETUP X.X INSERT STEP: MANUAL
PREV ENTR EXIT
SETUP X.X O3 GEN MODE: OFF
OFF CNST REF BNCH ENTR EXIT
This Key Turns the the O3 Generator OFF/ON
• REF: The concentration control loop will use the generator's reference detector as input.
• BNCH: The concentration control loop will use the photometer bench.
This key sets a CONSTANT drive voltage for the O3 Generator
These keys set a target concentration for the O3 Generator
SETUP X.X O3 GEN SET POINT: 0.0 MV
0 0 0 0 .0 ENTR EXIT
SETUP X.X O3 GEN SET POINT: 000.0 PPB
0 0 0 0 .0 ENTR EXIT
Toggle these keys to set output CONCENTRATION of the O3 generator
Toggle these keys to set the CONSTANT drive voltage of the O3 generator
STANDBY LEVEL:0
0 0 ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle these keys until the designation of the existing defined level program is reached.
EXIT discards the new LEVEL number
ENTR accepts the new LEVEL number

6.12.5.3. Editing or Deleting a LEVEL

To edit or delete an existing **LEVEL**, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 LEVL SEQ CFG CLK PASS MORE EXIT
SETUP X.X [LEVEL ID]) [Gas/Conc.], [Status Block Set]
PREV NEXT INS DEL EDIT PRNT EXIT
Continue pressing NEXT or PREV until until LEVEL to be edited or deleted appears
SETUP X.X 25) 150 PPB O3, 04 00
PREV NEXT INS DEL EDIT EXIT
SETUP X.X DELETEL STEP?
YES NO
Toggle these keys select the parameter to be edited
• Level ID Number
• Action
• Status Block 1
• Status Block 2
SETUP X.X LEVEL NUMBER:12
<SET SET> EDIT EXIT
Press EDIT then follow the instructions for the parameter
(See Sections 6.12.5.1. through 6.12.5.3.

Levels are displayed according to the following Format:

- LEVEL ID: Any number between 0 and 99. This will be the number used to select the level when activating / deactivating it, or when editing or deleting it.
- Gas Conc: The concentration setting, in ppb, for the O3 generator to produce.
- Status Block Setting: This will be displayed as two pairs of 1-digit numbers.
  - The First pair corresponds to Status Block 1.
  - The Second pair corresponds to Status Block 2.

  n each case:
  - The left digit will be a number between 1 and 4 representing the binary setting of bits 1 through 4 and;
  - The right digit will be a number between 1 and 4 representing the binary setting of bits 5 through 8.

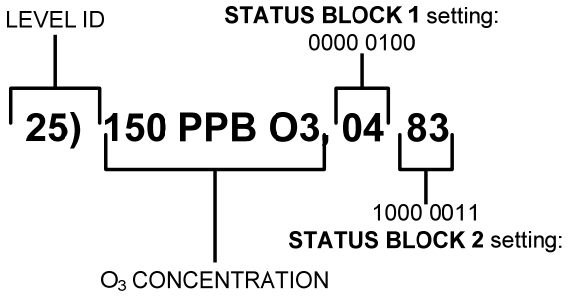


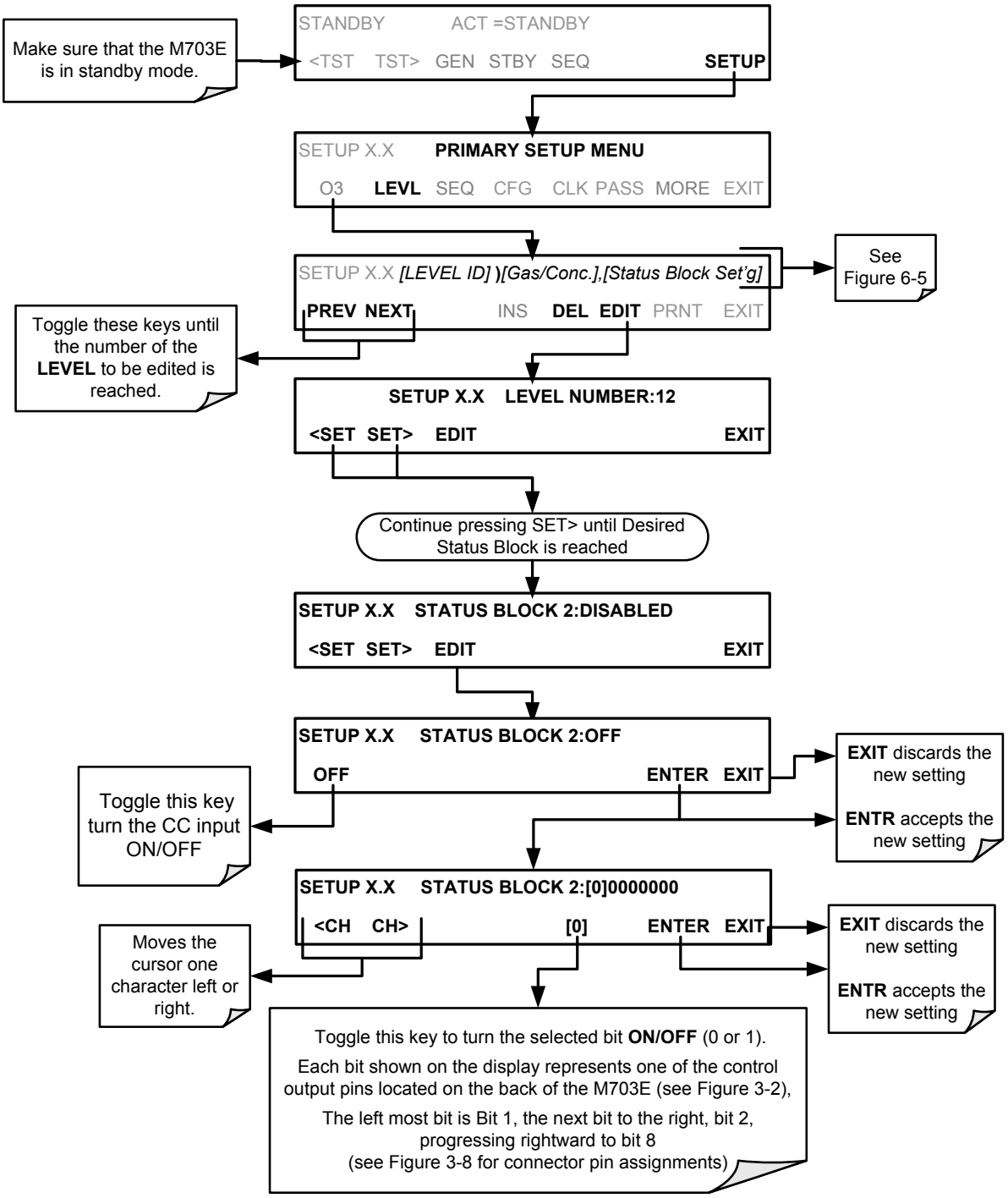
Figure 6-5: LEADS Level Display Format

6.12.6. CONFIGURING LEVEL STATUS BLOCKS

There are two **STATUS BLOCKS** associated with LEADS **LEVELS**.

- **BLOCK 1:** This block corresponds to the physical CONTROL OUTPUT connections located on the back panel of the M703E (see Figure 3-2, Figure 3-8 and Section 3.2.5).
- **BLOCK 2**: The second status block does not correspond to any physical output but is used to communicate status over the serial data port

To configure the either of the **STATUS BLOCKS**, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 LEVL SEQ CFG CLK PASS MORE EXIT
SETUP X.X [LEVEL ID])[Gas/Conc.],[Status Block Set'g]
PREV NEXT INS DEL EDIT PRNT EXIT
See Figure 6-5
Toggle these keys until the number of the LEVEL to be edited is reached.
SETUP X.X LEVEL NUMBER:12
<SET SET> EDIT EXIT
Continue pressing SET> until Desired Status Block is reached
SETUP X.X STATUS BLOCK 2:DISABLED
<SET SET> EDIT EXIT
SETUP X.X STATUS BLOCK 2:OFF
OFF ENTER EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle this key turn the CC input ON/OFF
SETUP X.X STATUS BLOCK 2:[0]0000000
<CH CH> [0] ENTER EXIT
EXIT discards the new setting
ENTR accepts the new setting
Moves the cursor one character left or right.
Toggle this key to turn the selected bit ON/OFF (0 or 1).
Each bit shown on the display represents one of the control output pins located on the back of the M703E (see Figure 3-2),
The left most bit is Bit 1, the next bit to the right, bit 2, progressing rightward to bit 8
(see Figure 3-8 for connector pin assignments)

7. OPERATING THE M703E OVER THE SERIAL I/O PORTS

7.1. USING THE ANALYSER'S COMMUNICATION PORTS

The M703E is equipped with two serial communication ports located on the rear panel accessible via 2 DB-9 connectors on the back panel of the instrument (See Figure 3-2). The COM1 connector is a male DB-9 connector and the COM2 is a female DB9 connector.

Both ports operate similarly and give the user the ability to communicate with, issue commands to, and receive data from the calibrator through an external computer system or terminal.

- The RS-232 port (COM1) can also be configured to operate in single or RS-232 multidrop mode (option 62; See Section 5.2.3 and7.3.
- The COM2 port can be configured for standard RS-232 operation, half-duplex RS-485 communication or for access via an LAN by installing the Teledyne Instruments' Ethernet interface card (see Section 5.2.4 and 7.5).

7.1.1. RS-232 DTE AND DCE COMMUNICATION

RS-232 was developed for allowing communications between data terminal equipment (DTE) and data communication equipment (DCE). Basic data terminals always fall into the DTE category whereas modems are always considered DCE devices.

Electronically, the difference between the DCE & DTE is the pin assignment of the Data Receive and Data Transmit functions.

- DTE devices receive data on pin 2 and transmit data on pin 3.
- DCE devices receive data on pin 3 and transmit data on pin 2.

A switch located below the serial ports on the rear panel allows the user to switch between DTE (for use with data terminals) or DCE (for use with modems). Since computers can be either DTE or DCE, check your computer to determine which mode to use.

7.1.2. COMM PORT DEFAULT SETTINGS AND CONNECTOR PIN ASSIGNMENTS

Received from the factory, the calibrator is set up to emulate an RS-232 DCE device.

- **RS-232 (COM1)**: RS-232 (fixed), DB-9 male connector.
  - **Baud rate**: 19200 bits per second (baud).
  - **Data Bits**: 8 data bits with 1 stop bit.
  - **Parity**: None.
- **COM2**: RS-232 (configurable to RS 485), DB-9 female connector.
  - **Baud rate**: 115000 bits per second (baud).
  - **Data Bits**: 8 data bits with 1 stop bit.
  - **Parity**: None.

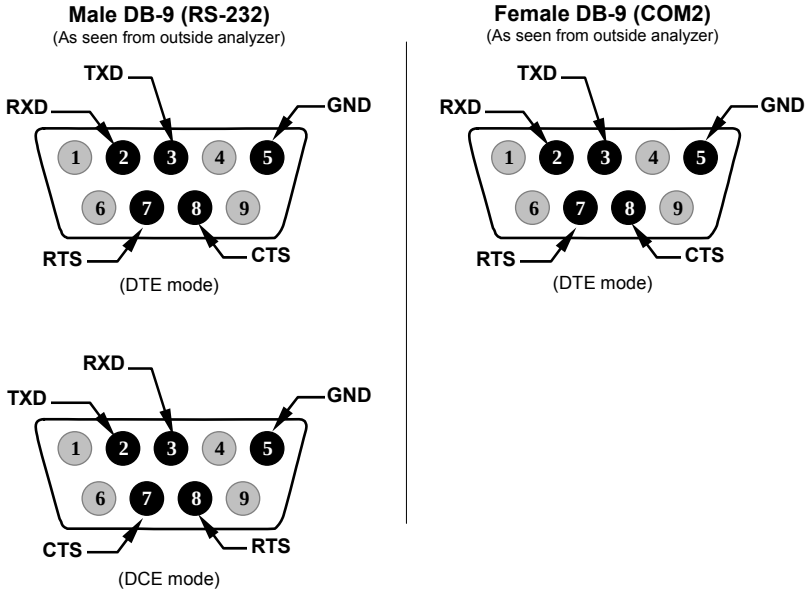


Figure 7-1: Default Pin Assignments for Back Panel COMM Port connectors (RS-232 DCE & DTE)

The signals from these two connectors are routed from the motherboard via a wiring harness to two 10-pin connectors on the CPU card, CN3 (COM1) and CN4 (COM2).

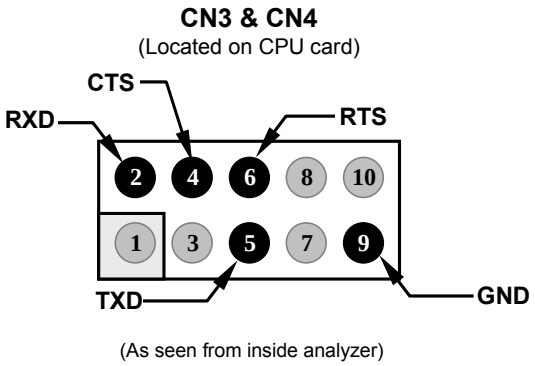


Figure 7-2: Default Pin Assignments for CPU COM Port connector (RS-232).

Teledyne Instruments offers two mating cables, one of which should be applicable for your use.

- Part number WR000077, a DB-9 female to DB-9 female cable, 6 feet long. Allows connection of the serial ports of most personal computers. Also available as Option 60 (See Section 5.2.1).
- Part number WR000024, a DB-9 female to DB-25 male cable. Allows connection to the most common styles of modems (e.g. Hayes-compatible) and code activated switches.

Both cables are configured with straight-through wiring and should require no additional adapters.

NOTE

Cables that appear to be compatible because of matching connectors may incorporate internal wiring that makes the link inoperable. Check cables acquired from sources other than Teledyne Instruments for pin assignments before using.

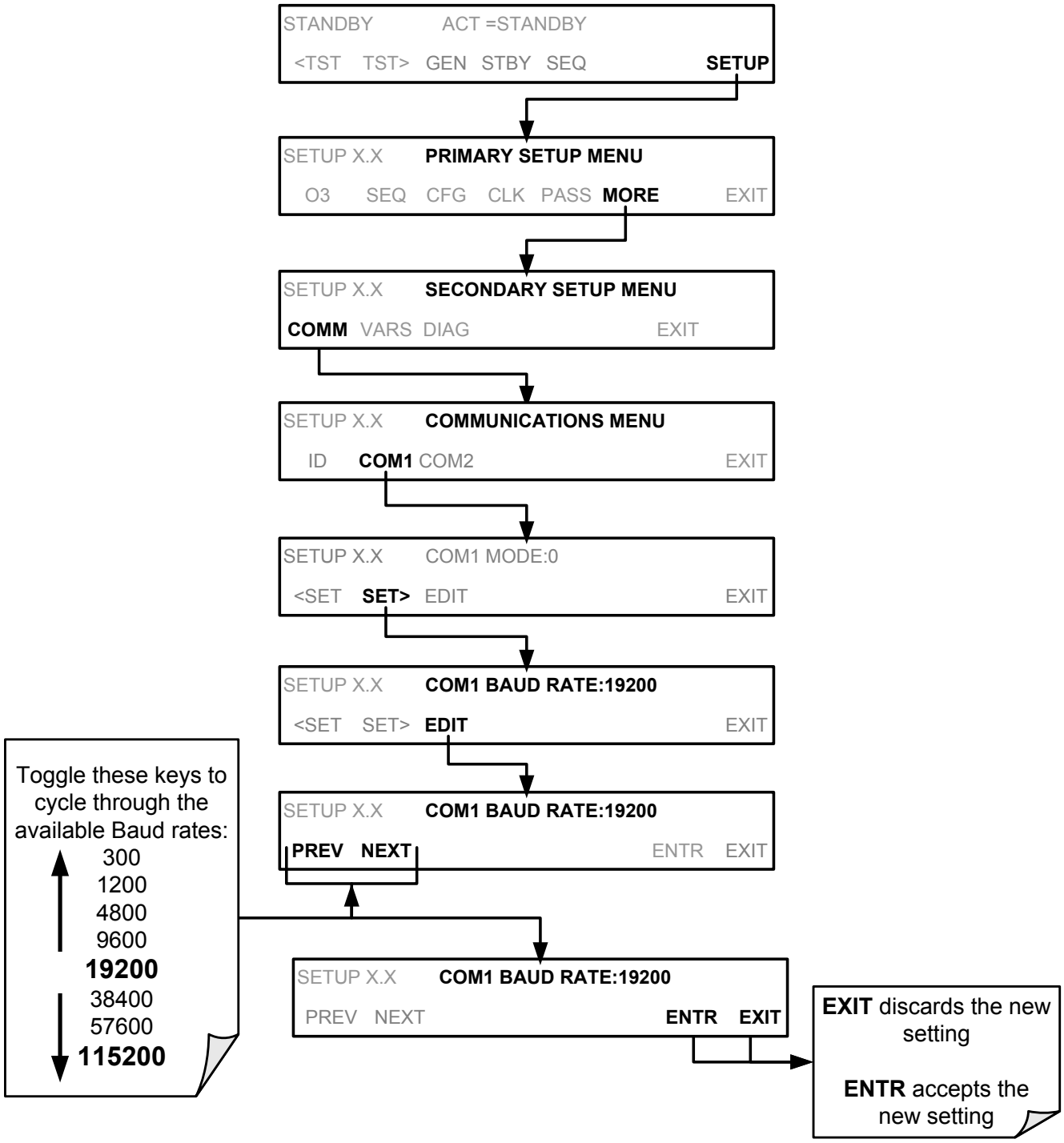
To assist in properly connecting the serial ports to either a computer or a modem, there are activity indicators just above the RS-232 port. Once a cable is connected between the calibrator and a computer or modem, both the red and green LEDs should be on.

If the lights are not lit, use the small switch on the rear panel to switch it between DTE and DCE modes

If both LEDs are still not illuminated, make sure the cable properly constructed.

7.1.3. COMM PORT BAUD RATE

To select the baud rate of either one of the COM Ports, press:



7.1.4. COMM PORT COMMUNICATION MODES

Each of the calibrator's serial ports can be configured to operate in a number of different modes, listed in Table 7-1. As modes are selected, the calibrator sums the Mode ID numbers and displays this combined number on the front panel display. For example, if quiet mode (01), computer mode (02) and Multi-Drop-enabled mode (32) are selected, the Calibrator would display a combined **MODE ID** of **35**.

Table 7-1: COMM Port Communication Modes

MODE[1]	ID	DESCRIPTION
QUIET	**1**	Quiet mode suppresses any feedback from the calibrator (such as warning messages) to the remote device and is typically used when the port is communicating with a computer program where such intermittent messages might cause communication problems. Such feedback is still available but a command must be issued to receive them.
COMPUTER	**2**	Computer mode inhibits echoing of typed characters and is used when the port is communicating with a computer operated control program.
SECURITY	**4**	When enabled, the serial port requires a password before it will respond. The only command that is active is the help screen (? CR).
E, 7, 1	**2048**	When turned on this mode switches the **COM** port settings from No parity; 8 data bits; 1 stop bit to Even parity; 7 data bits; 1 stop bit
RS-485	**1024**	Configures the **COM2** Port for RS-485 communication. RS-485 mode has precedence over multidrop mode if both are enabled.
MULTIDROP PROTOCOL	**32**	Multidrop protocol allows a multi-instrument configuration on a single communications channel. Multidrop requires the use of instrument IDs.
ENABLE MODEM	**64**	Enables to send a modem initialization string at power-up. Asserts certain lines in the RS-232 port to enable the modem to communicate.
ERROR CHECKING[2]	**128**	Fixes certain types of parity errors at certain Hessen protocol installations.
XON/XOFF HANDSHAKE[2]	**256**	Disables XON/XOFF data flow control also known as software handshaking.
HARDWARE HANDSHAKE	**8**	Enables CTS/RTS style hardwired transmission handshaking. This style of data transmission handshaking is commonly used with modems or terminal emulation protocols as well as by Teledyne Instrument's APICOM software.
HARDWARE FIFO[2]	**512**	Disables the **HARDWARE FIFO** (First In – First Out), When FIFO is enabled it improves data transfer rate for that COM port.
COMMAND PROMPT	**4096**	Enables a command prompt when in terminal mode.

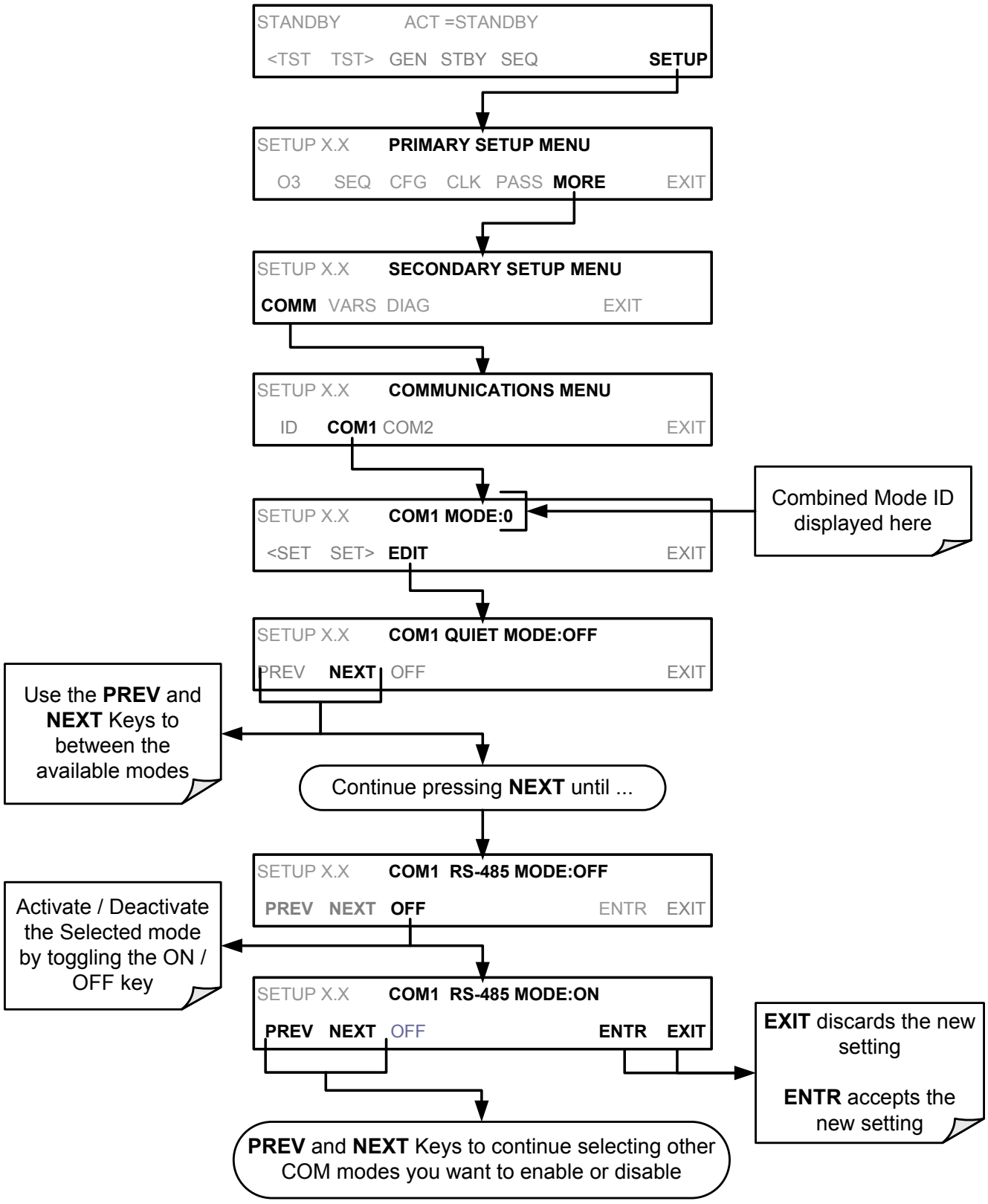
[1] Modes are listed in the order in which they appear in the **SETUP → MORE → COMM → COM[1 OR 2] → MODE** menu

[2] The default setting for this feature is **ON.** Do not disable unless instructed to by Teledyne Instruments' Customer Service personnel.

Note

Communication Modes for each COM port must be configured independently.

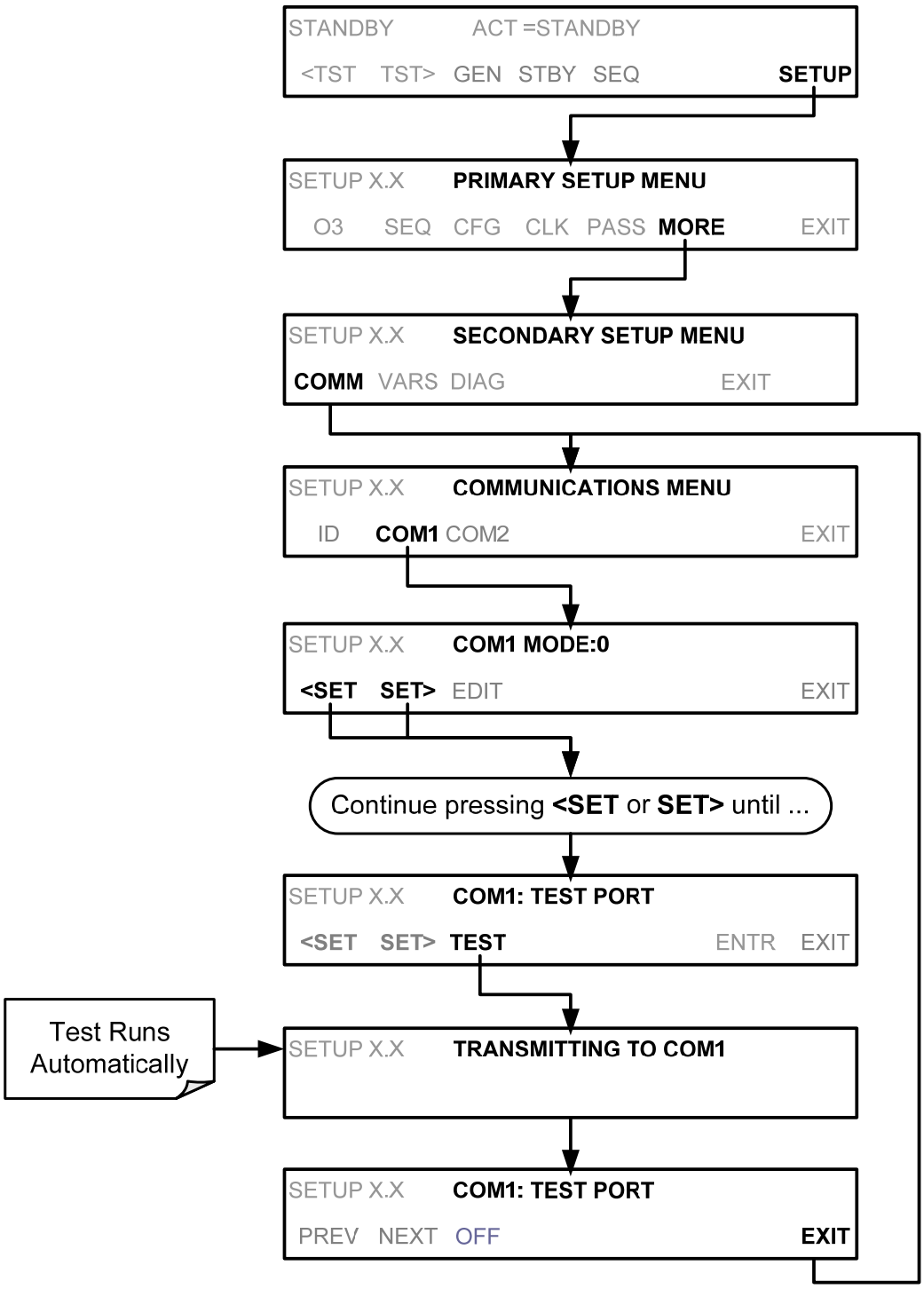
Press the following keys to select communication modes for a one of the COMM Ports, such as the following example where **RS-485** mode is enabled:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X COMMUNICATIONS MENU
ID COM1 COM2 EXIT
SETUP X.X COM1 MODE:0
<SET SET> EDIT EXIT
Combined Mode ID displayed here
SETUP X.X COM1 QUIET MODE:OFF
PREV NEXT OFF EXIT
Use the PREV and NEXT Keys to between the available modes
Continue pressing NEXT until ...
SETUP X.X COM1 RS-485 MODE:OFF
PREV NEXT OFF ENTR EXIT
Activate / Deactivate the Selected mode by toggling the ON / OFF key
SETUP X.X COM1 RS-485 MODE:ON
PREV NEXT OFF ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting
PREV and NEXT Keys to continue selecting other COM modes you want to enable or disable

7.1.5. COMM PORT TESTING

The serial ports can be tested for correct connection and output in the **COM** menu. This test sends a string of 256 'w' characters to the selected COM port. While the test is running, the red LED on the rear panel of the calibrator should flicker.

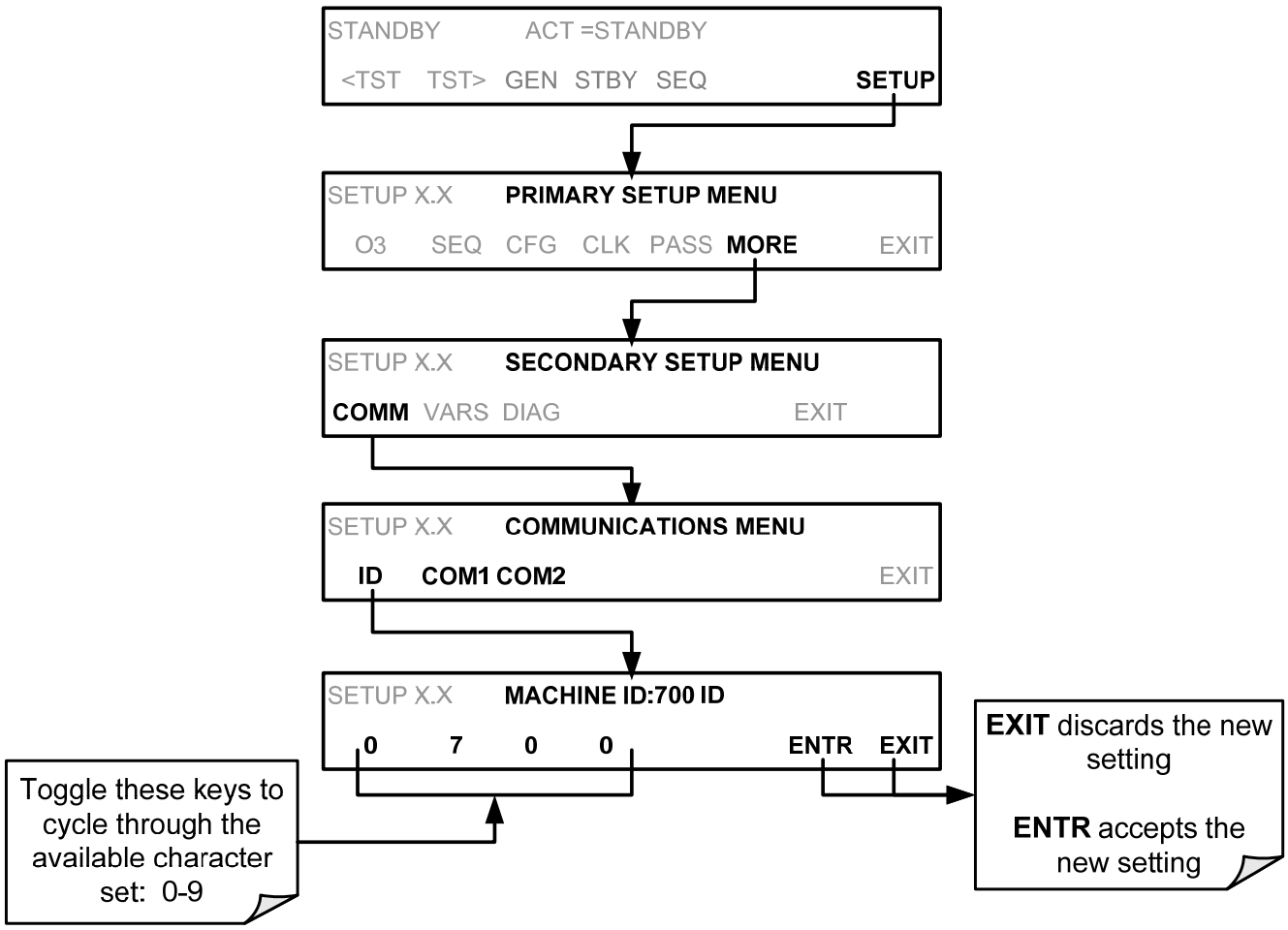
To initiate the test press the following key sequence.


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X COMMUNICATIONS MENU
ID COM1 COM2 EXIT
SETUP X.X COM1 MODE:0
<SET SET> EDIT EXIT
Continue pressing <SET or SET> until ...
SETUP X.X COM1: TEST PORT
<SET SET> TEST ENTR EXIT
Test Runs Automatically
SETUP X.X TRANSMITTING TO COM1
SETUP X.X COM1: TEST PORT
PREV NEXT OFF EXIT

7.1.6. MACHINE ID

Each type of Teledyne Instruments calibrator is configured with a default ID code. The default ID code for all M703E calibrators is **700**. The ID number is only important if more than one calibrator is connected to the same communications channel such as when several calibrators are on the same Ethernet LAN, in a RS-232 multidrop chain (See Section 7.3) or operating over a RS-485 network (See Section 7.4). If two calibrators of the same model type are used on one channel, the ID codes of one or both of the instruments needs to be changed so

To edit the instrument's ID code, press:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X COMMUNICATIONS MENU
ID COM1 COM2 EXIT
SETUP X.X MACHINE ID:700 ID
0 7 0 0 ENTR EXIT
Toggle these keys to cycle through the available character set: 0-9
EXIT discards the new setting
ENTR accepts the new setting

The ID number is only important if more than one calibrator is connected to the same communications channel (e.g., a multi-drop setup). Different models of Teledyne Instruments' calibrators have different default ID numbers, but if two calibrators of the same model type are used on one channel (for example, two M703E's), the ID of one instrument needs to be changed.

The ID can also be used for to identify any one of several calibrators attached to the same network but situated in different physical locations.

7.1.7. TERMINAL OPERATING MODES

The M703E can be remotely configured, calibrated or queried for stored data through the serial ports. As terminals and computers use different communication schemes, the calibrator supports two communicate modes specifically designed to interface with these two types of devices.

- Computer mode is used when the calibrator is connected to a computer with a dedicated interface program.
- Interactive mode is used with a terminal emulation programs such as HyperTerminal or a "dumb" computer terminal. The commands that are used to operate the calibrator in this mode are listed in Table 7-2.

7.1.7.1. Help Commands in Terminal Mode

Table 7-2: Terminal Mode Software Commands

COMMAND	Function
Control-T	Switches the calibrator to terminal mode (echo, edit). If mode flags 1 & 2 are OFF, the interface can be used in interactive mode with a terminal emulation program.
Control-C	Switches the calibrator to computer mode (no echo, no edit).
CR (carriage return)	A carriage return is required after each command line is typed into the terminal/computer. The command will not be sent to the calibrator to be executed until this is done. On personal computers, this is achieved by pressing the ENTER key.
BS (backspace)	Erases one character to the left of the cursor location.
ESC (escape)	Erases the entire command line.
? [ID] CR	This command prints a complete list of available commands along with the definitions of their functionality to the display device of the terminal or computer being used. The ID number of the calibrator is only necessary if multiple calibrators are on the same communications line, such as the multi-drop setup.
Control-C	Pauses the listing of commands.
Control-P	Restarts the listing of commands.

7.1.7.2. Command Syntax

Commands are not case-sensitive and all arguments within one command (i.e. ID numbers, keywords, data values, etc.) must be separated with a space character.

All Commands follow the syntax:

X [ID] COMMAND <CR>

Where

X is the command type (one letter) that defines the type of command. Allowed designators are listed in Table 6-27 and Appendix A-6.

[ID] is the machine identification number (Section 7.1.6). Example: the Command "? 200" followed by a carriage return would print the list of available commands for the revision of software currently installed in the instrument assigned ID Number 200.

COMMAND is the command designator: This string is the name of the command being issued (LIST, ABORT, NAME, EXIT, etc.). Some commands may have additional arguments that define how the command is to be executed. Press ? <CR> or refer to Appendix A-6 for a list of available command designators.

<CR> is a carriage return. All commands must be terminated by a carriage return (usually achieved by pressing the ENTER key on a computer).

Table 7-3: Teledyne Instruments Serial I/O Command Types

COMMAND	COMMAND TYPE
C	Calibration
D	Diagnostic
L	Logon
T	Test measurement
V	Variable
W	Warning

7.1.7.3. Data Types

Data types consist of integers, hexadecimal integers, floating-point numbers, Boolean expressions and text strings.

- Integer data are used to indicate integral quantities such as a number of records, a filter length, etc. They consist of an optional plus or minus sign, followed by one or more digits. For example, *+1*, *-12*, *123* are all valid integers.

- Hexadecimal integer data are used for the same purposes as integers. They consist of the two characters "0x," followed by one or more hexadecimal digits (0-9, A-F, a-f), which is the 'C' programming language convention. No plus or minus sign is permitted. For example, *0x1*, *0x12*, *0x1234abcd* are all valid hexadecimal integers.

- Floating-point numbers are used to specify continuously variable values such as temperature set points, time intervals, warning limits, voltages, etc. They consist of an optional plus or minus sign, followed by zero or more digits, an optional decimal point and zero or more digits. (At least one digit must appear before or after the decimal point.) Scientific notation is not permitted. For example, *+1.0*, *1234.5678*, *-0.1*, *1* are all valid floating-point numbers.

- Boolean expressions are used to specify the value of variables or I/O signals that may assume only two values. They are denoted by the keywords *ON* and *OFF*.

- Text strings are used to represent data that cannot be easily represented by other data types, such as data channel names, which may contain letters and numbers. They consist of a quotation mark, followed by one or more printable characters, including spaces, letters, numbers, and symbols, and a final quotation mark. For example, *"a"*, *"1"*, *"123abc"*, and *"()[]<>"* are all valid text strings. It is not possible to include a quotation mark character within a text string.

- Some commands allow you to access variables, messages, and other items. When using these commands, you must type the entire name of the item; you cannot abbreviate any names.

7.1.7.4. Status Reporting

Reporting of status messages as an audit trail is one of the three principal uses for the RS-232 interface (the other two being the command line interface for controlling the instrument and the download of data in electronic format). You can effectively disable the reporting feature by setting the interface to quiet mode (Section 7.1.4, Table 7-1).

Status reports include warning messages, calibration and diagnostic status messages. Refer to Appendix A-3 for a list of the possible messages, and this for information on controlling the instrument through the RS-232 interface.

General Message Format

All messages from the instrument (including those in response to a command line request) are in the format:

X DDD:HH:MM [Id] MESSAGE<CRLF>

Where:

X	is a command type designator, a single character indicating the message type, as shown in the Table 6-27.
DDD:HH:MM	is the time stamp, the date and time when the message was issued. It consists of the Day-of-year (DDD) as a number from 1 to 366, the hour of the day (HH) as a number from 00 to 23, and the minute (MM) as a number from 00 to 59.
[ID]	is the calibrator ID, a number with 1 to 4 digits.
MESSAGE	is the message content that may contain warning messages, Test Functions, variable values, etc.
<CRLF>	is a carriage return / line feed pair, which terminates the message.

The uniform nature of the output messages makes it easy for a host computer to parse them into an easy structure. Keep in mind that the front panel display does not give any information on the time a message was issued, hence it is useful to log such messages for trouble-shooting and reference purposes. Terminal emulation programs such as HyperTerminal can capture these messages to text files for later review.

7.1.7.5. COM Port Password Security

In order to provide security for remote access of the M703E, a LOGON feature can be enabled to require a password before the instrument will accept commands. This is done by turning on the **SECURITY MODE** (Mode 4, Section 7.1.4). Once the **SECURITY MODE** is enabled, the following items apply.

- A password is required before the port will respond or pass on commands.
- If the port is inactive for one hour, it will automatically logoff, which can also be achieved with the LOGOFF command.
- Three unsuccessful attempts to log on with an incorrect password will cause subsequent logins to be disabled for 1 hour, even if the correct password is used.
- If not logged on, the only active command is the '?' request for the help screen.
- The following messages will be returned at logon:
  - LOGON SUCCESSFUL - Correct password given
  - LOGON FAILED - Password not given or incorrect
  - LOGOFF SUCCESSFUL - Connection terminated successfully

To log on to the M703E calibrator with **SECURITY MODE** feature enabled, type:

LOGON 940331

940331 is the default password. To change the default password, use the variable RS232_PASS issued as follows:

V RS232_PASS=NNNNNN

Where N is any numeral between 0 and 9.

7.2. REMOTE ACCESS BY MODEM

The M703E can be connected to a modem for remote access. This requires a cable between the calibrator's COM port and the modem, typically a DB-9F to DB-25M cable (available from Teledyne Instruments with part number WR0000024).

Once the cable has been connected, check to make sure:

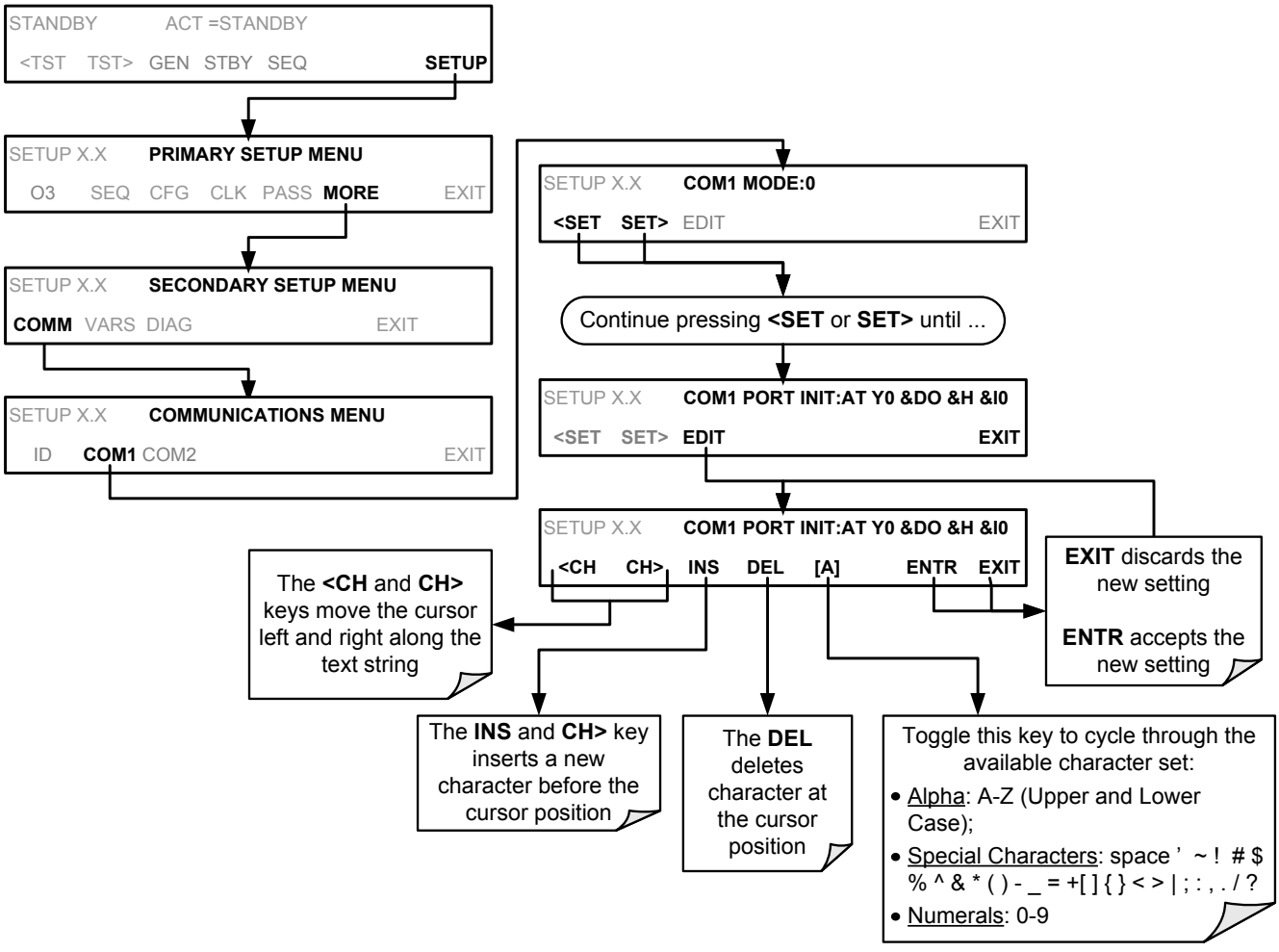
- The DTE-DCE is in the DCE position.
- The M703E COM port is set for a baud rate that is compatible with the modem,
- The Modem is designed to operate with an 8-bit word length with one stop bit.
- The **MODEM ENABLE** communication mode is turned **ON** (Mode 64, see Section 7.1.4).

Once this is completed, the appropriate setup command line for your modem can be entered into the calibrator. The default setting for this feature is

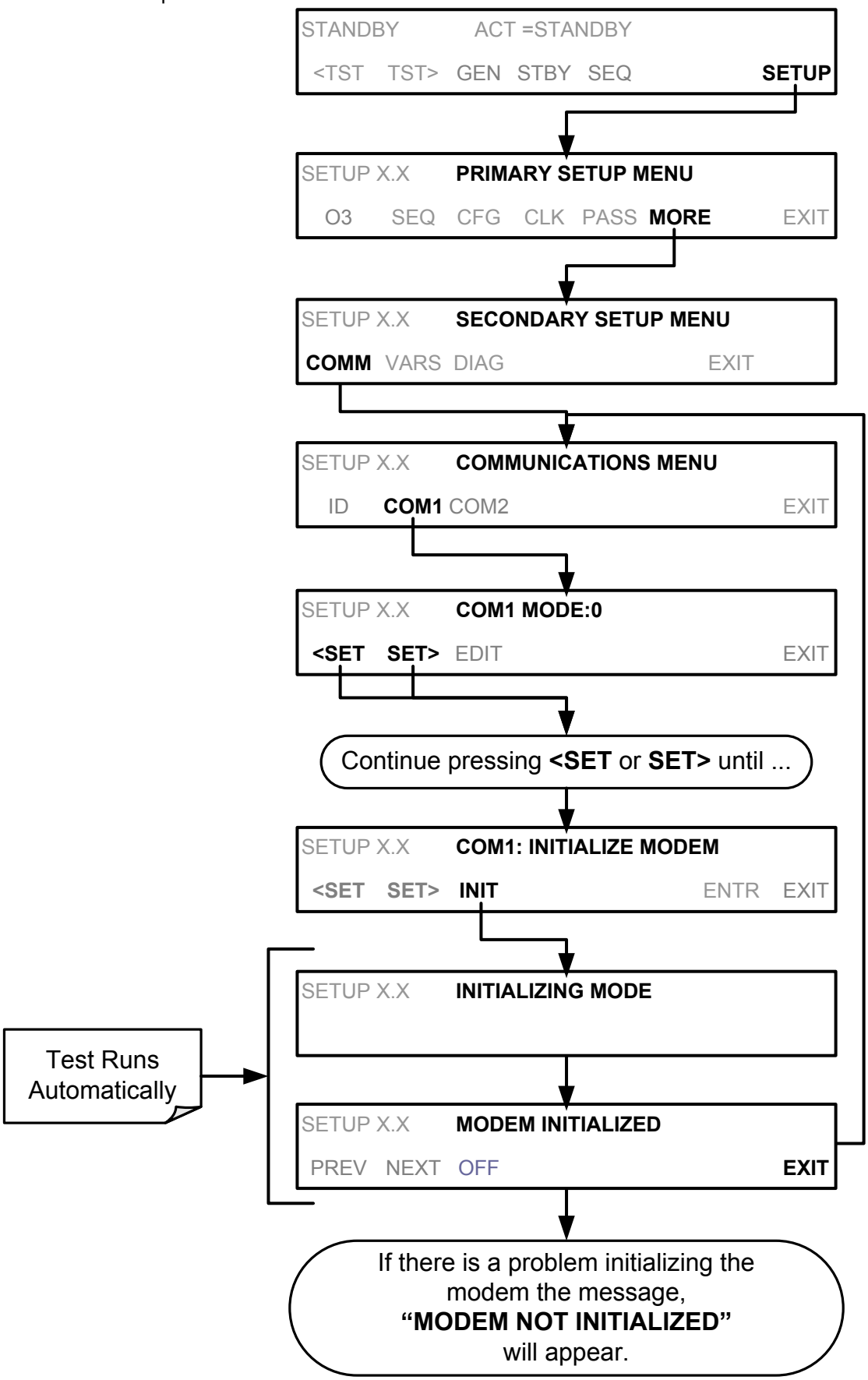
AT Y0 &D0 &H0 &I0 S0=2 &B0 &N6 &M0 E0 Q1 &W0

This string can be altered to match your modem's initialization and can be up to 100 characters long.

To change this setting press:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X COMMUNICATIONS MENU
ID COM1 COM2 EXIT
SETUP X.X COM1 MODE:0
<SET SET> EDIT EXIT
Continue pressing <SET or SET> until ...
SETUP X.X COM1 PORT INIT:AT Y0 &DO &H &I0
<SET SET> EDIT EXIT
SETUP X.X COM1 PORT INIT:AT Y0 &DO &H &I0
<CH CH> INS DEL [A] ENTR EXIT
The <CH and CH> keys move the cursor left and right along the text string
EXIT discards the new setting
ENTR accepts the new setting
The INS and CH> key inserts a new character before the cursor position
The DEL deletes character at the cursor position
Toggle this key to cycle through the available character set:
• Alpha: A-Z (Upper and Lower Case);
• Special Characters: space ' ~ ! # $ % ^ & * ( ) - _ = +[ ] { } < > | ; : , . / ?
• Numerals: 0-9

To Initialize the modem press:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X COMMUNICATIONS MENU
ID COM1 COM2 EXIT
SETUP X.X COM1 MODE:0
<SET SET> EDIT EXIT
Continue pressing <SET or SET> until ...
SETUP X.X COM1: INITIALIZE MODEM
<SET SET> INIT ENTR EXIT
SETUP X.X INITIALIZING MODE
Test Runs Automatically
SETUP X.X MODEM INITIALIZED
PREV NEXT OFF EXIT
If there is a problem initializing the modem the message, "MODEM NOT INITIALIZED" will appear.

7.3. MULTIDROP RS-232 SET UP

The RS-232 multidrop consists of a printed circuit assembly that plugs onto the CN3, CN4 and CN5 connectors of the CPU card and the cabling to connect it to the calibrator's motherboard. This PCA includes all circuitry required to enable your calibrator for multidrop operation. It converts the instrument's COM1 port to multidrop configuration allowing up to eight Teledyne Instruments E-Series calibrators or E-Series analyzers to be connected the same I/O port of the host computer.

Because both of the DB9 connectors on the calibrator's back panel are needed to construct the multidrop chain, COM2 is no longer available for separate RS-232 or RS-485 operation; however, with the addition of an Ethernet Option (option 63, See Section5.2.4 and 7.5) the COM2 port is available for communication over a 10BaseT LAN.

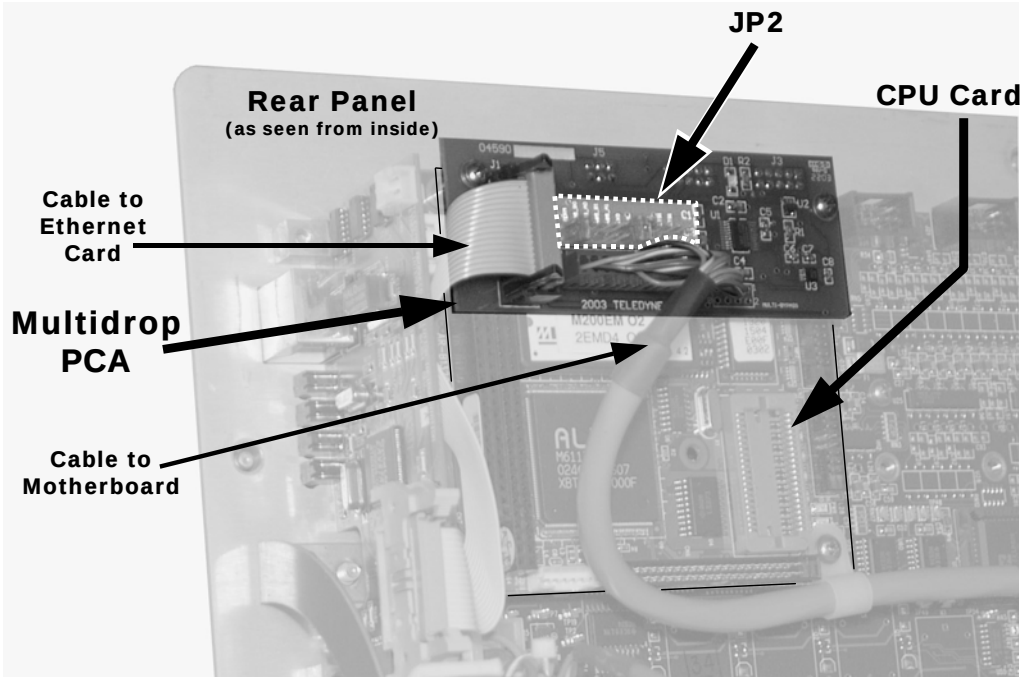


Figure 7-3: Location of JP2 on RS232-Multidrop PCA (option 62)

Each calibrator or analyzer in the multidrop chain must have:

- One Teledyne Instruments Option 62 installed.
- One 6' straight-through, DB9 male → DB9 Female cable (Teledyne Instruments P/N WR0000101) is required for each calibrator.

To set up the network, for each instrument:

4. Turn the instrument on and change its MACHINE ID code to a unique 4-digit number.
5. Remove the top cover of the instrument and locate JP2 on the multidrop PCA (7-4)
6. Make sure that the jumpers are in place connection pins 9 ↔ 10 and 11 ↔ 12.
7. If the instrument is to be the last instrument on the chain, make sure a jumper is in place connecting pins 21 ↔ 22.
8. If you are adding an instrument to the end of an already existing chain, do not forget to remove JP2, pins 21 ↔ 22 on the multidrop PCA on the instrument that was previously the last instrument in the chain.
9. Close the instrument.

10. Using straight-through, DB9 male → DB9 Female cables, interconnect the host and the calibrators as shown in Figure 6-14.

NOTE:

Teledyne Instruments recommends setting up the first link, between the Host and the first instrument and testing it before setting up the rest of the chain.

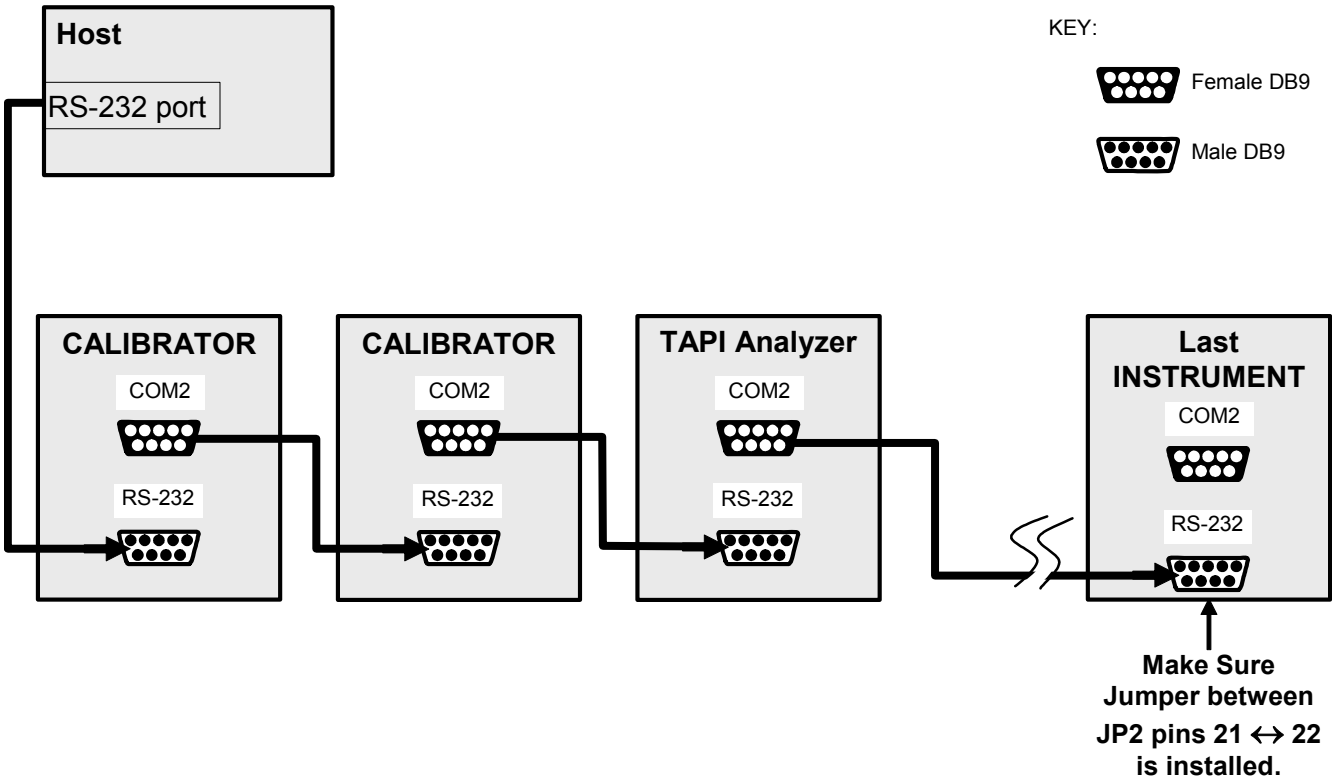


Figure 7-4: RS232-Multidrop PCA Host/Calibrator Interconnect Diagram

7.4. RS-485 CONFIGURATION OF COM2

As delivered from the factory, COM2 is configured for RS-232 communications. This port can be re-configured for operation as a non-isolated, half-duplex RS-485 port capable of supporting up to 32 instruments with a maximum distance between the host and the furthest instrument being 4000 feet. If you require full-duplex or isolated operation, please contact Teledyne Instruments Customer Service.

- To reconfigure COM2 as an RS-285 port set switch 6 of SW1 to the ON position (see Figure 7-6).
- The RS-485 port can be configured with or without a 150 Ω termination resistor. To include the resistor, install jumper at position JP3 on the CPU board (see Figure 7-6). To configure COM2 as an un-terminated RS-485 port leave JP3 open.

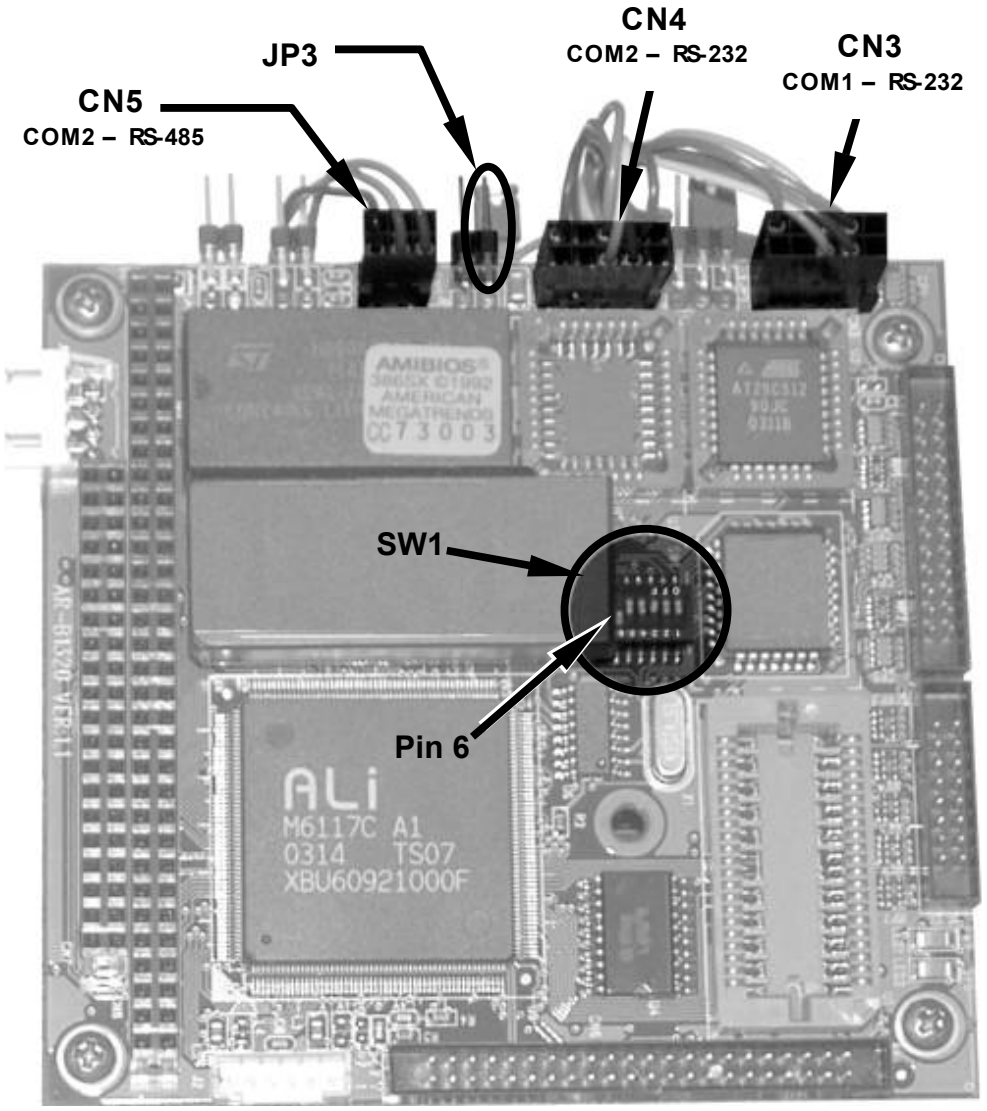


Figure 7-5: CPU card Locations of RS-232/485 Switches, Connectors and Jumpers

When COM2 is configured for RS-485 operation the port uses the same female DB-9 connector on the back of the instrument as when Com2 is configured for RS-232 operation, however, the pin assignments are different.

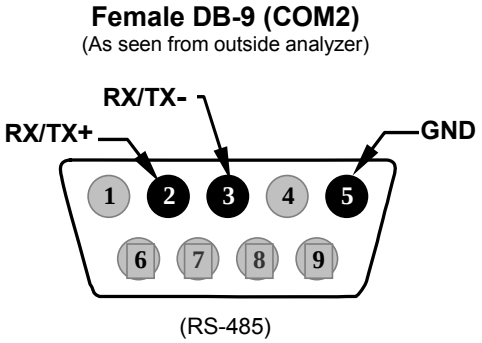


Figure 7-6: Back Panel connector Pin-Outs for COM2 in RS-485 mode.

The signal from this connector is routed from the motherboard via a wiring harness to a 6-pin connector on the CPU card, CN5.

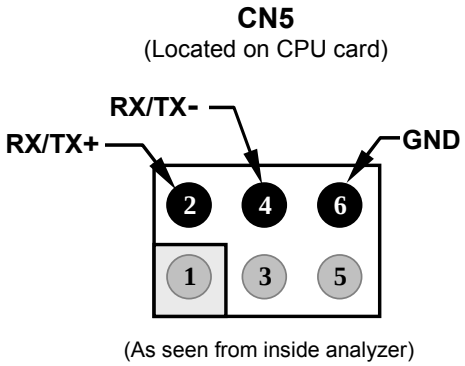


Figure 7-7: CPU connector Pin-Outs for COM2 in RS-485 mode.

7.5. REMOTE ACCESS VIA THE ETHERNET

When equipped with the optional Ethernet interface, the calibrator can be connected to any standard 10BaseT Ethernet network via low-cost network hubs, switches or routers. The interface operates as a standard TCP/IP device on port 3000. This allows a remote computer to connect through the internet to the calibrator using APICOM, terminal emulators or other programs.

The firmware on board the Ethernet card automatically sets the communication modes and baud rate (115,200 kBaud) for the **COM2** port. Once the Ethernet option is installed and activated, the **COM2** submenu is replaced by a new submenu, **INET**. This submenu is used to manage and configure the Ethernet interface with your LAN or Internet Server(s).

The card has four LEDs that are visible on the rear panel of the calibrator, indicating its current operating status.

Table 7-4: Ethernet Status Indicators

LED	FUNCTION
LNK (green)	ON when connection to the LAN is valid.
ACT (yellow)	Flickers on any activity on the LAN.
TxD (green)	Flickers when the RS-232 port is transmitting data.
RxD (yellow)	Flickers when the RS-232 port is receiving data.

7.5.1. ETHERNET CARD COM2 COMMUNICATION MODES AND BAUD RATE

The firmware on board the Ethernet card automatically sets the communication modes for the COM2 port. The baud rate is also automatically set at 115 200 kBaud.

7.5.2. CONFIGURING THE ETHERNET INTERFACE OPTION USING DHCP

The Ethernet option for you M703E uses Dynamic Host Configuration Protocol (DHCP) to configure its interface with your LAN automatically. This requires your network servers also be running DHCP. The calibrator will do this the first time you turn the instrument on after it has been physically connected to your network. Once the instrument is connected and turned on, it will appear as an active device on your network without any extra set up steps or lengthy procedures.

NOTE

It is a good idea to check the INET settings the first time you power up your calibrator after it has been physically connected to the LAN/Internet to make sure that the DHCP has successfully downloaded the appropriate information from you network server(s).

The Ethernet configuration properties are viewable via the calibrator's front panel.

Table 7-5: LAN/Internet Configuration Properties

PROPERTY	DEFAULT STATE		DESCRIPTION
DHCP STATUS	On	Editable	This displays whether the DHCP is turned ON or OFF.
INSTRUMENT IP ADDRESS	Configured by DHCP	**EDIT** key disabled when DHCP is **ON**	This string of four packets of 1 to 3 numbers each (e.g. 192.168.76.55.) is the address of the calibrator itself.
GATEWAY IP ADDRESS	Configured by DHCP	**EDIT** key disabled when DHCP is **ON**	A string of numbers very similar to the Instrument IP address (e.g. 192.168.76.1.) that is the address of the computer used by your LAN to access the Internet.
SUBNET MASK	Configured by DHCP	**EDIT** key disabled when DHCP is **ON**	Also a string of four packets of 1 to 3 numbers each (e.g. 255.255.252.0) that identifies the LAN to which the device is connected. All addressable devices and computers on a LAN must have the same subnet mask. Any transmissions sent to devices with different subnet masks are assumed to be outside of the LAN and are therefore routed through a gateway computer onto the Internet.
TCP PORT	**3000**	Editable, but **DO NOT CHANGE**	This number defines the terminal control port by which the instrument is addressed by terminal emulation software, such as Internet or Teledyne Instruments' APICOM.
HOST NAME	**M703E**	Editable	The name by which your calibrator will appear when addressed from other computers on the LAN or via the Internet. The default setting for all Teledyne Instruments M703E calibrators is "M703E". The host name may be changed to fit customer needs.

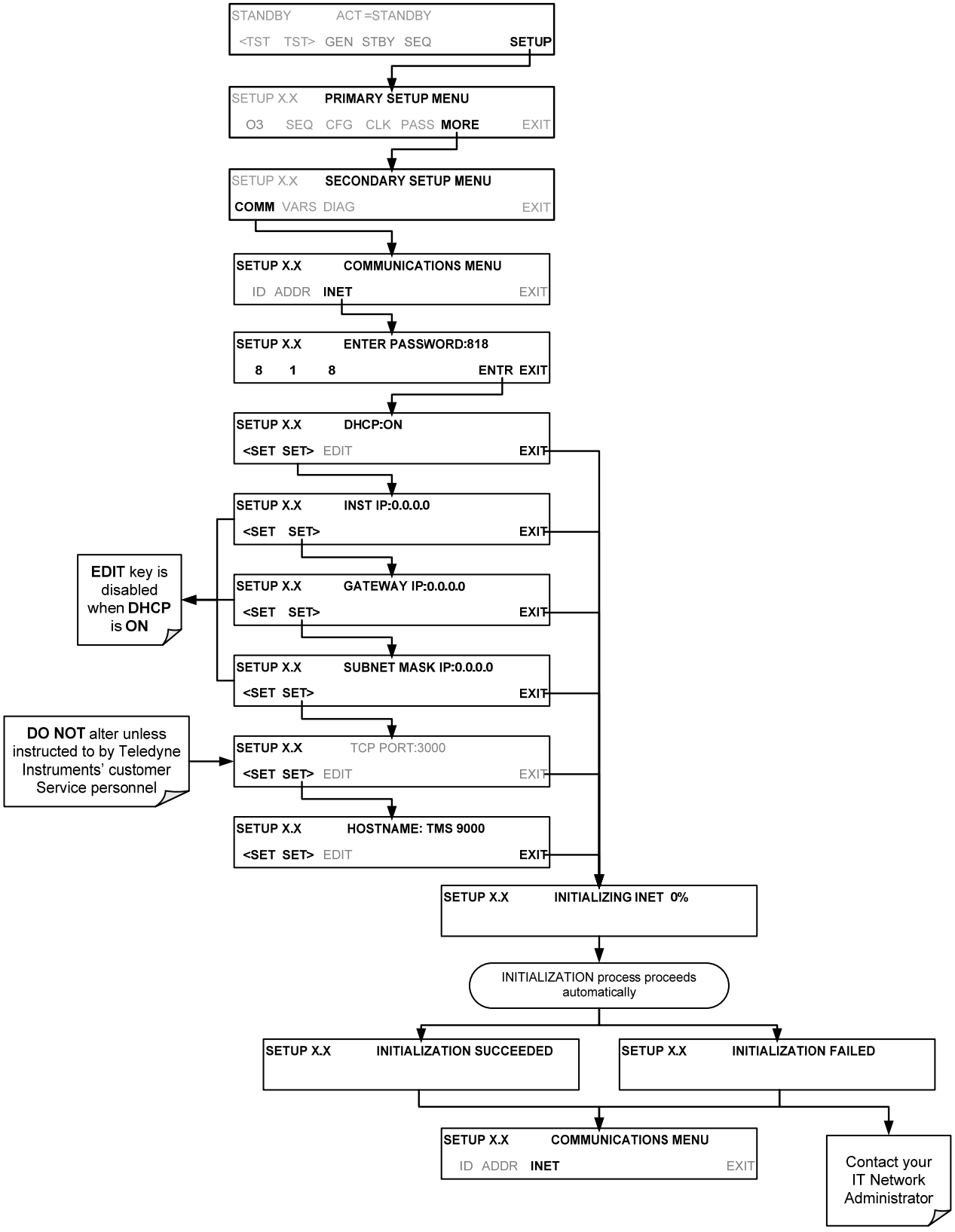
[1] Do not change the setting for this property unless instructed to by Teledyne Instruments Customer Service personnel.

NOTE

If the gateway IP, instrument IP and the subnet mask are all zeroes (e.g. "0.0.0.0"), the DCHP was not successful in which case you may have to configure the calibrator's Ethernet properties manually.

See your network administrator.

To view the above properties listed in Table 7-5, press:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X COMMUNICATIONS MENU
ID ADDR INET EXIT
SETUP X.X ENTER PASSWORD:818
8 1 8 ENTR EXIT
SETUP X.X DHCP:ON
<SET SET> EDIT EXIT
SETUP X.X INST IP:0.0.0.0
<SET SET> EXIT
SETUP X.X GATEWAY IP:0.0.0.0
<SET SET> EXIT
SETUP X.X SUBNET MASK IP:0.0.0.0
<SET SET> EXIT
SETUP X.X TCP PORT:3000
<SET SET> EDIT EXIT
SETUP X.X HOSTNAME: TMS 9000
<SET SET> EDIT EXIT
EDIT key is disabled when DHCP is ON
DO NOT alter unless instructed to by Teledyne Instruments' customer Service personnel
SETUP X.X INITIALIZING INET 0%
INITIALIZATION process proceeds automatically
SETUP X.X INITIALIZATION SUCCEEDED
SETUP X.X INITIALIZATION FAILED
SETUP X.X COMMUNICATIONS MENU
ID ADDR INET EXIT
Contact your IT Network Administrator

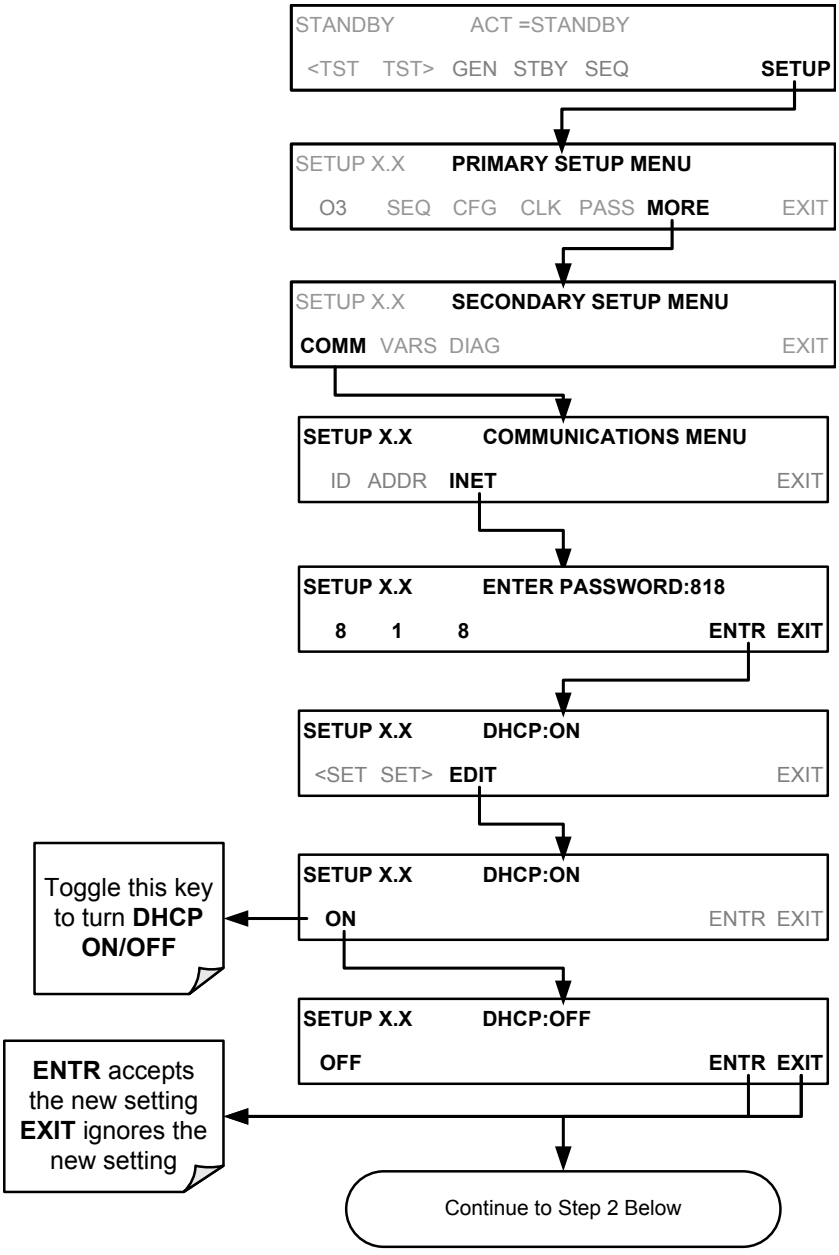
7.5.2.1. Manually Configuring the Network IP Addresses

There are several circumstances when you may need to configure the interface settings of the calibrator's Ethernet card manually. The **INET** sub-menu may also be used to edit the Ethernet card's configuration properties

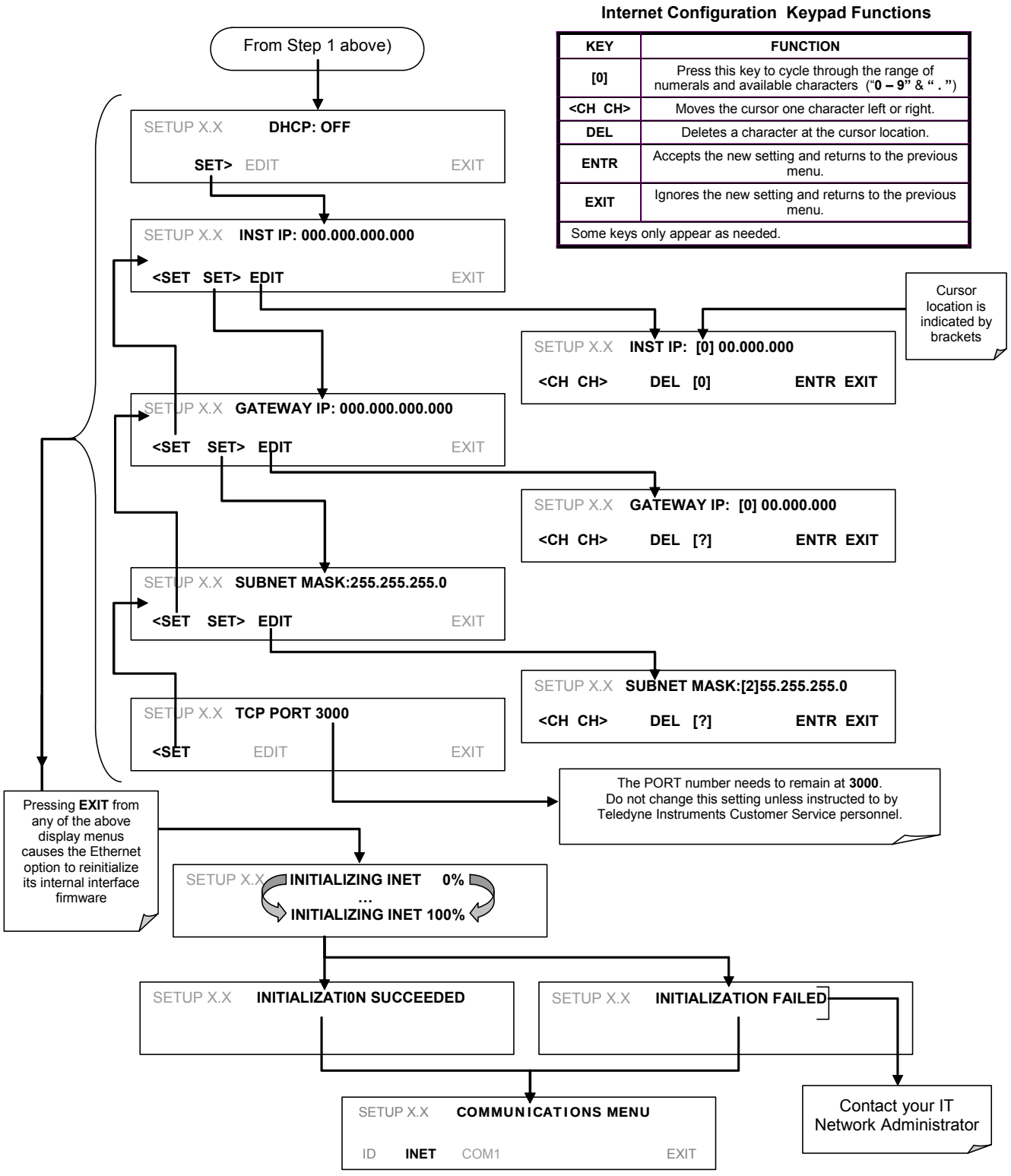
- Your LAN is not running a DHCP software package,
- The DHCP software is unable to initialize the calibrator's interface;
- You wish to program the interface with a specific set of IP addresses that may not be the ones automatically chosen by DHCP.

Editing the Ethernet Interface properties is a two-step process.

STEP 1: Turn DHCP **OFF**: While DHCP is turned **ON**, the ability to set **INSTRUMENT IP**, **GATEWAY IP** and **SUBNET MASK** manually is disabled

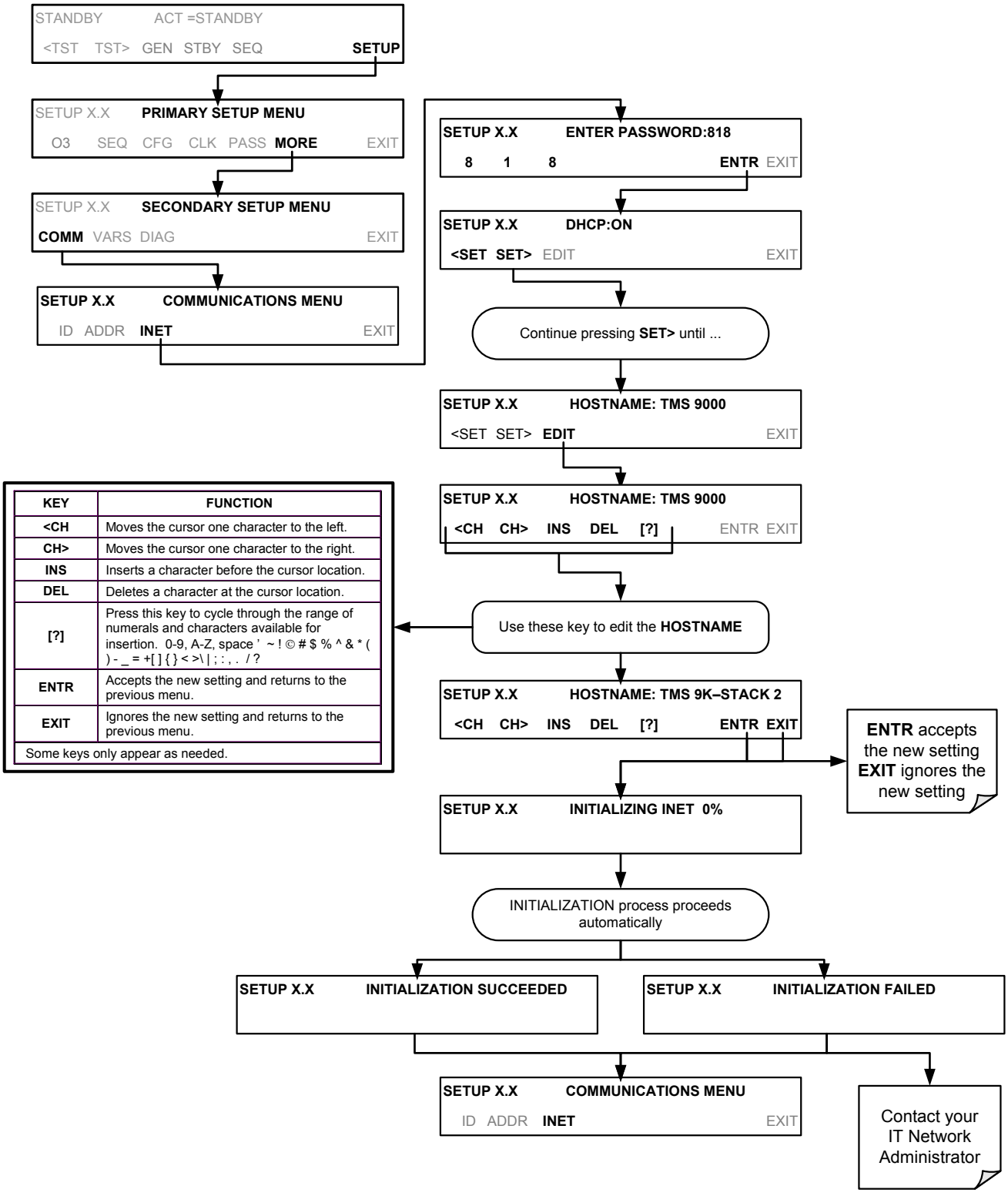

STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X COMMUNICATIONS MENU
ID ADDR INET EXIT
SETUP X.X ENTER PASSWORD:818
8 1 8 ENTR EXIT
SETUP X.X DHCP:ON
<SET SET> EDIT EXIT
SETUP X.X DHCP:ON
ON ENTR EXIT
Toggle this key to turn DHCP ON/OFF
SETUP X.X DHCP:OFF
OFF ENTR EXIT
ENTR accepts the new setting
EXIT ignores the new setting
Continue to Step 2 Below

STEP 2: Configure the **INSTRUMENT IP**, **GATEWAY IP** and **SUBNET MASK** addresses by pressing:


Internet Configuration Keypad Functions
KEY
FUNCTION
[0]
Press this key to cycle through the range of numerals and available characters ("0 – 9" & " . ")
<CH CH>
Moves the cursor one character left or right.
DEL
Deletes a character at the cursor location.
ENTR
Accepts the new setting and returns to the previous menu.
EXIT
Ignores the new setting and returns to the previous menu.
Some keys only appear as needed.
From Step 1 above)
SETUP X.X DHCP: OFF
SET> EDIT EXIT
SETUP X.X INST IP: 000.000.000.000
<SET SET> EDIT EXIT
Cursor location is indicated by brackets
SETUP X.X INST IP: [0] 00.000.000
<CH CH> DEL [0] ENTR EXIT
SETUP X.X GATEWAY IP: 000.000.000.000
<SET SET> EDIT EXIT
SETUP X.X GATEWAY IP: [0] 00.000.000
<CH CH> DEL [?] ENTR EXIT
SETUP X.X SUBNET MASK:255.255.255.0
<SET SET> EDIT EXIT
SETUP X.X SUBNET MASK:[2]55.255.255.0
<CH CH> DEL [?] ENTR EXIT
SETUP X.X TCP PORT 3000
<SET EDIT EXIT
The PORT number needs to remain at 3000. Do not change this setting unless instructed to by Teledyne Instruments Customer Service personnel.
Pressing EXIT from any of the above display menus causes the Ethernet option to reinitialize its internal interface firmware
SETUP X.X INITIALIZING INET 0%
...
INITIALIZING INET 100%
SETUP X.X INITIALIZATI0N SUCCEEDED
SETUP X.X INITIALIZATION FAILED
SETUP X.X COMMUNICATIONS MENU
ID INET COM1 EXIT
Contact your IT Network Administrator

7.5.3. CHANGING THE CALIBRATOR'S HOSTNAME

The **HOSTNAME** is the name by which the calibrator appears on your network. The default name for all Teledyne Instruments M703E calibrators is **M703E**. To change this name (particularly if you have more than one M703E calibrator on your network), press.


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X COMMUNICATIONS MENU
ID ADDR INET EXIT
SETUP X.X ENTER PASSWORD:818
8 1 8 ENTR EXIT
SETUP X.X DHCP:ON
<SET SET> EDIT EXIT
Continue pressing SET> until ...
SETUP X.X HOSTNAME: TMS 9000
<SET SET> EDIT EXIT
SETUP X.X HOSTNAME: TMS 9000
<CH CH> INS DEL [?] ENTR EXIT
Use these key to edit the HOSTNAME
SETUP X.X HOSTNAME: TMS 9K–STACK 2
<CH CH> INS DEL [?] ENTR EXIT
ENTR accepts the new setting EXIT ignores the new setting
SETUP X.X INITIALIZING INET 0%
INITIALIZATION process proceeds automatically
SETUP X.X INITIALIZATION SUCCEEDED
SETUP X.X INITIALIZATION FAILED
SETUP X.X COMMUNICATIONS MENU
ID ADDR INET EXIT
Contact your IT Network Administrator

KEY	FUNCTION
<CH	Moves the cursor one character to the left.
CH>	Moves the cursor one character to the right.
INS	Inserts a character before the cursor location.
DEL	Deletes a character at the cursor location.
[?]	Press this key to cycle through the range of numerals and characters available for insertion. 0-9, A-Z, space ' ~ ! © # $ % ^ & * ( ) - _ = +[ ] { } < >\ | ; : , . / ?
ENTR	Accepts the new setting and returns to the previous menu.
EXIT	Ignores the new setting and returns to the previous menu.
Some keys only appear as needed.	

7.6. APICOM REMOTE CONTROL PROGRAM

APICOM is an easy-to-use, yet powerful interface program that allows the user to access and control any of Teledyne Instruments' main line of ambient and stack-gas instruments from a remote connection through direct cable, modem or Ethernet. Running APICOM, a user can:

- Establish a link from a remote location to the M703E through direct cable connection via RS-232 modem or Ethernet.
- View the instrument's front panel and remotely access all functions that could be accessed when standing in front of the instrument.
- Remotely edit system parameters and set points.
- Download, view, graph and save data for predictive diagnostics or data analysis.
- Retrieve, view, edit, save and upload iDAS configurations.
- Check on system parameters for trouble-shooting and quality control.

APICOM is very helpful for initial setup, data analysis, maintenance and trouble-shooting. Figure 7-8 shows examples of APICOM's main interface, which emulates the look and functionality of the instruments actual front panel

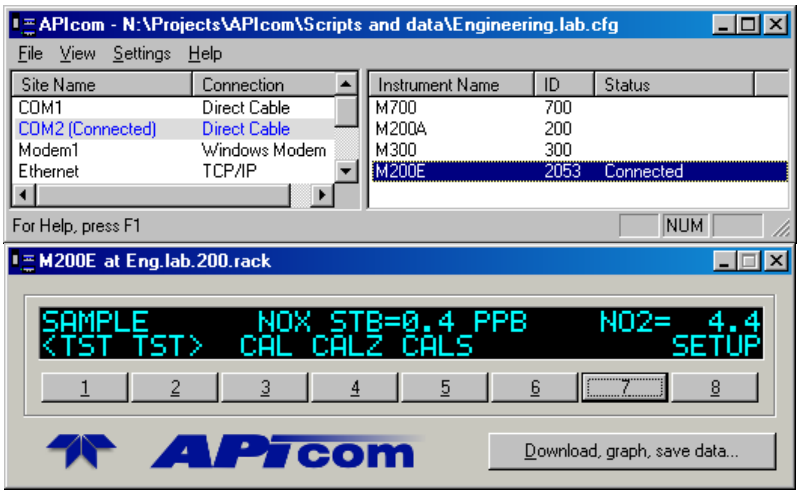


Figure 7-8: APICOM Remote Control Program Interface

NOTE

APICOM is included free of cost with the calibrator and the latest versions can also be downloaded for free at http://www.teledyne-api.com/software/apicom/.

The M703E calibrator is fully supported by APICOM revision 3.9.4 and later.

Instruments with the LEADS support option must run APICOM revision 4.0 and later

USER NOTES:

8. M703E CALIBRATION AND VERIFICATION

Basic electronic calibration of the M703E Calibrator is performed at the factory. Normally there is no need to perform this factory calibration in the field however, the performance of several of the instruments key subsystems should be verified periodically and if necessary adjusted. These subsystems are:

- O_3 Photometer: The O_3 photometer performance should be periodically verified against an external standard (see Section 8.1).
- O_3 Generator: The O_3 generator should be periodically calibrated (see Section 8.2).

8.1. VERIFYING AND CALIBRATING THE M703E'S O_3 PHOTOMETER

The accuracy of calibration gas produced by the M703E depends entirely on the accuracy of the photometer; therefore, it is very important that the photometer is operating properly and accurately.

The verification procedure can be performed using the instruments internal O_3 generator (see Figure 8-1) or an external source of O_3 (see Figure 8-2). In either case, an external source of zero air (such as a Teledyne Instruments' Model 701 Zero Air Generator) is required.

8.1.1. SETUP FOR VERIFYING AND CALIBRATING THE O_3 PHOTOMETER

Note

This operation requires an external reference photometer.

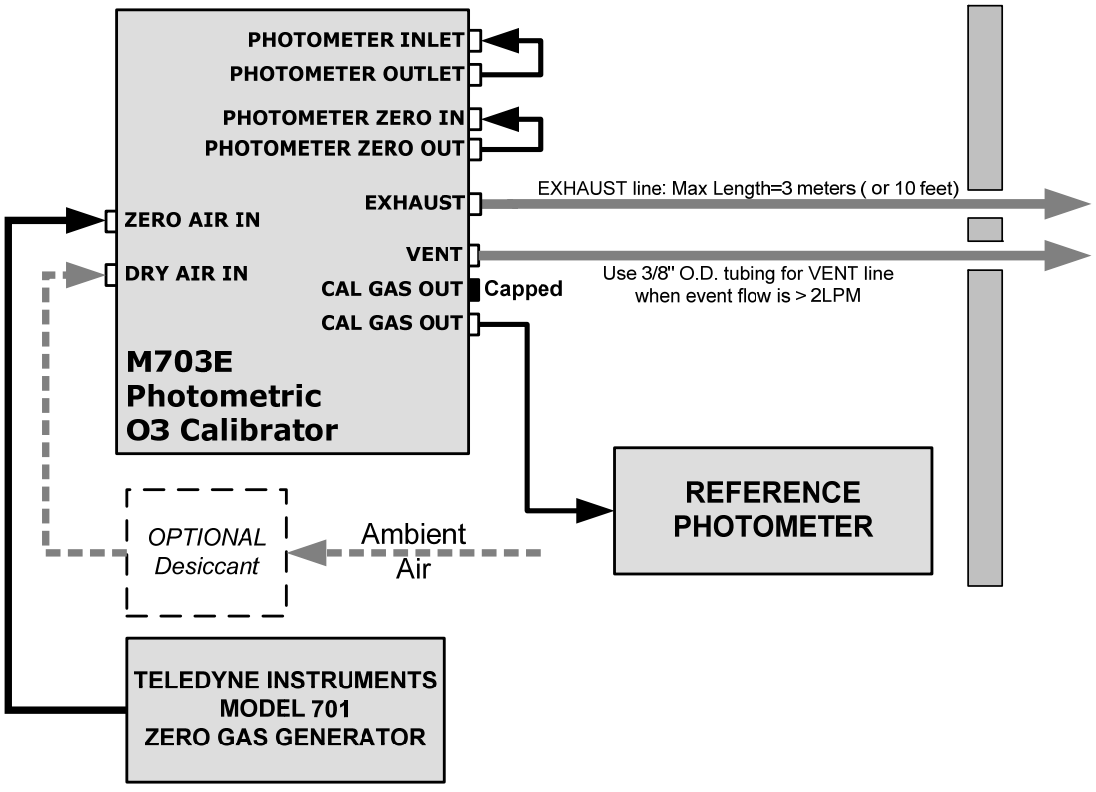


Figure 8-1: Set up for Verifying Optional O_3 Photometer Using Internal O_3 Generator

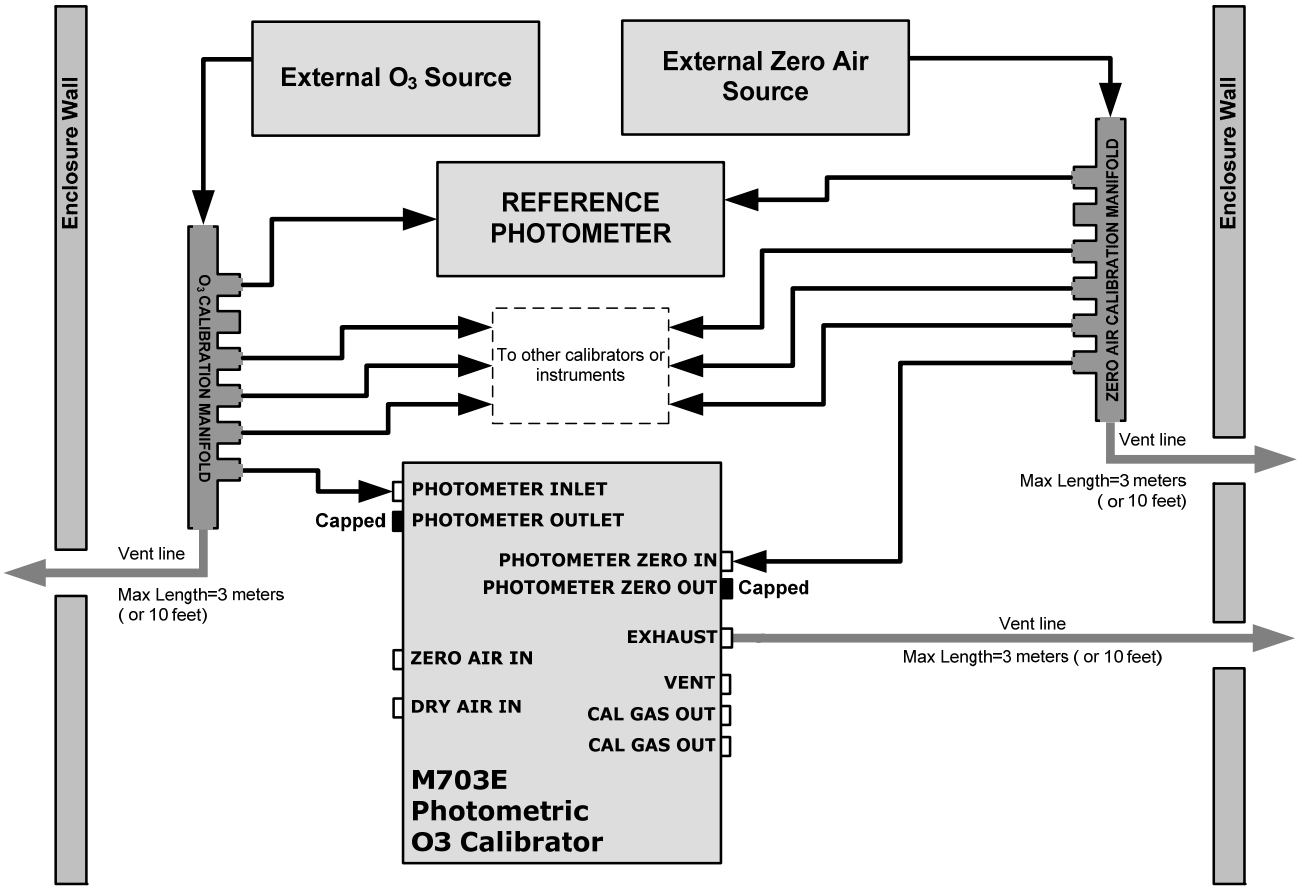


Figure 8-2: Set up for Verifying Optional O_3 Photometer Using an External O_3 Generator

NOTE

The manifolds as shown in the above drawing are oriented to simplify the drawing.

All unused ports should be capped.

A Minimum of 1.1 LPM is required for the external zero air source

8.1.1.1. Calibration Manifold Exhaust/Vent Line

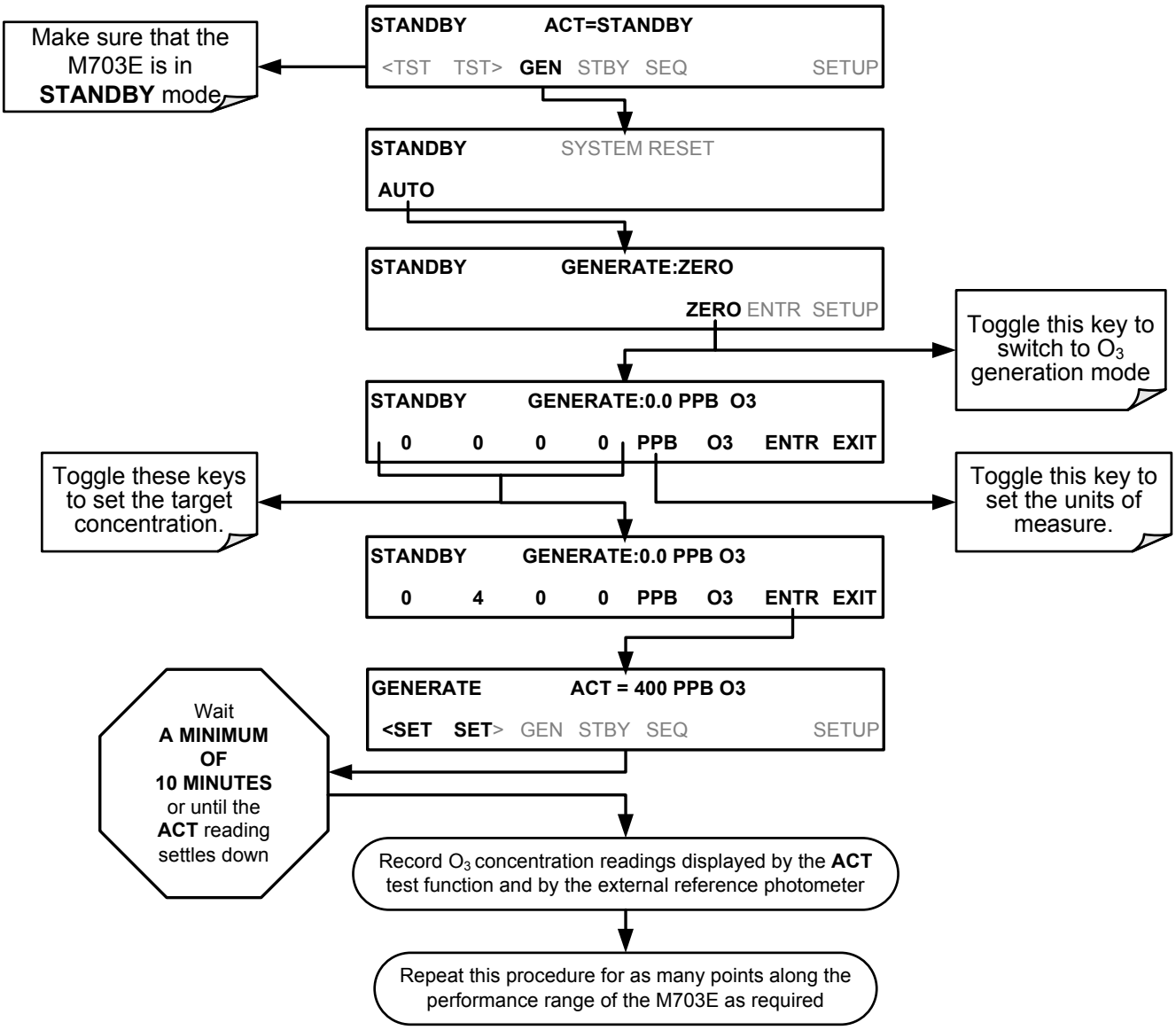
The manifold's excess gas should be vented to a suitable vent outside of the room. This vent should be of large enough internal diameter to avoid any appreciable pressure drop, and it must be located sufficiently downstream of the output ports to assure that no ambient air enters the manifold due to eddy currents or back diffusion.

NOTE

It is recommended that the calibration manifold's exhaust vent have a minimum internal diameter of 3/8 inch and a maximum length of 3 meters (or 10 feet)

8.1.2. VERIFYING O_3 PHOTOMETER PERFORMANCE

To verify the performance of the M703E's optional internal photometer perform the following steps:


Make sure that the M703E is in **STANDBY** mode.
STANDBY ACT=STANDBY
<TST TST> GEN STBY SEQ SETUP
STANDBY SYSTEM RESET
AUTO
STANDBY GENERATE:ZERO
ZERO ENTR SETUP
Toggle this key to switch to O3 generation mode
STANDBY GENERATE:0.0 PPB O3
0 0 0 0 PPB O3 ENTR EXIT
Toggle these keys to set the target concentration.
Toggle this key to set the units of measure.
STANDBY GENERATE:0.0 PPB O3
0 4 0 0 PPB O3 ENTR EXIT
GENERATE ACT = 400 PPB O3
<SET SET> GEN STBY SEQ SETUP
Wait A MINIMUM OF 10 MINUTES or until the ACT reading settles down
Record O3 concentration readings displayed by the ACT test function and by the external reference photometer
Repeat this procedure for as many points along the performance range of the M703E as required

NOTE

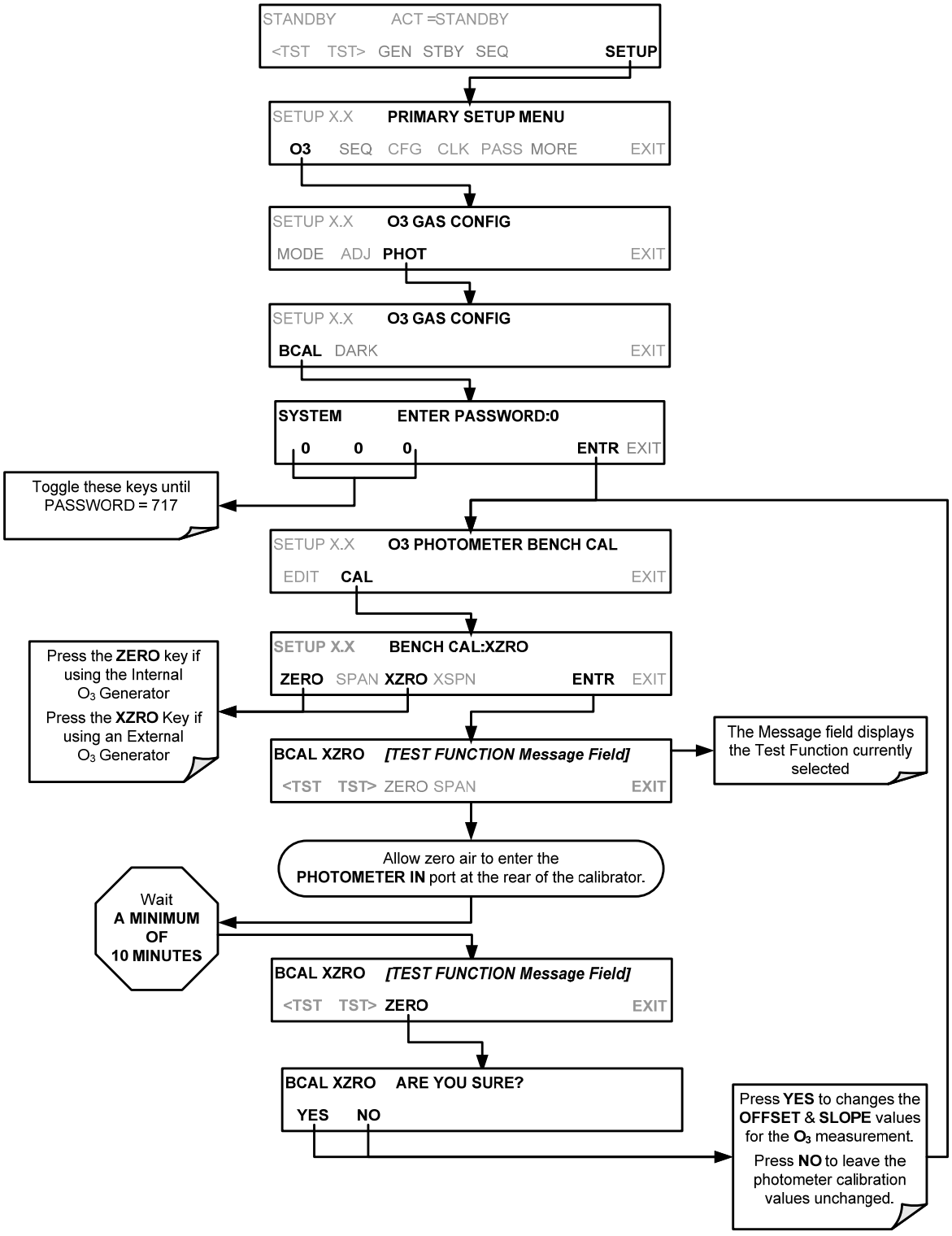
The readings recorded from the M703E's ACT test function and the external reference photometer should be within 1% of each other.

8.1.3. CALIBRATING THE O_3 PHOTOMETER

The following procedure sets values held in the calibrator's memory of for zero point **OFFSET** and **SLOPE.**

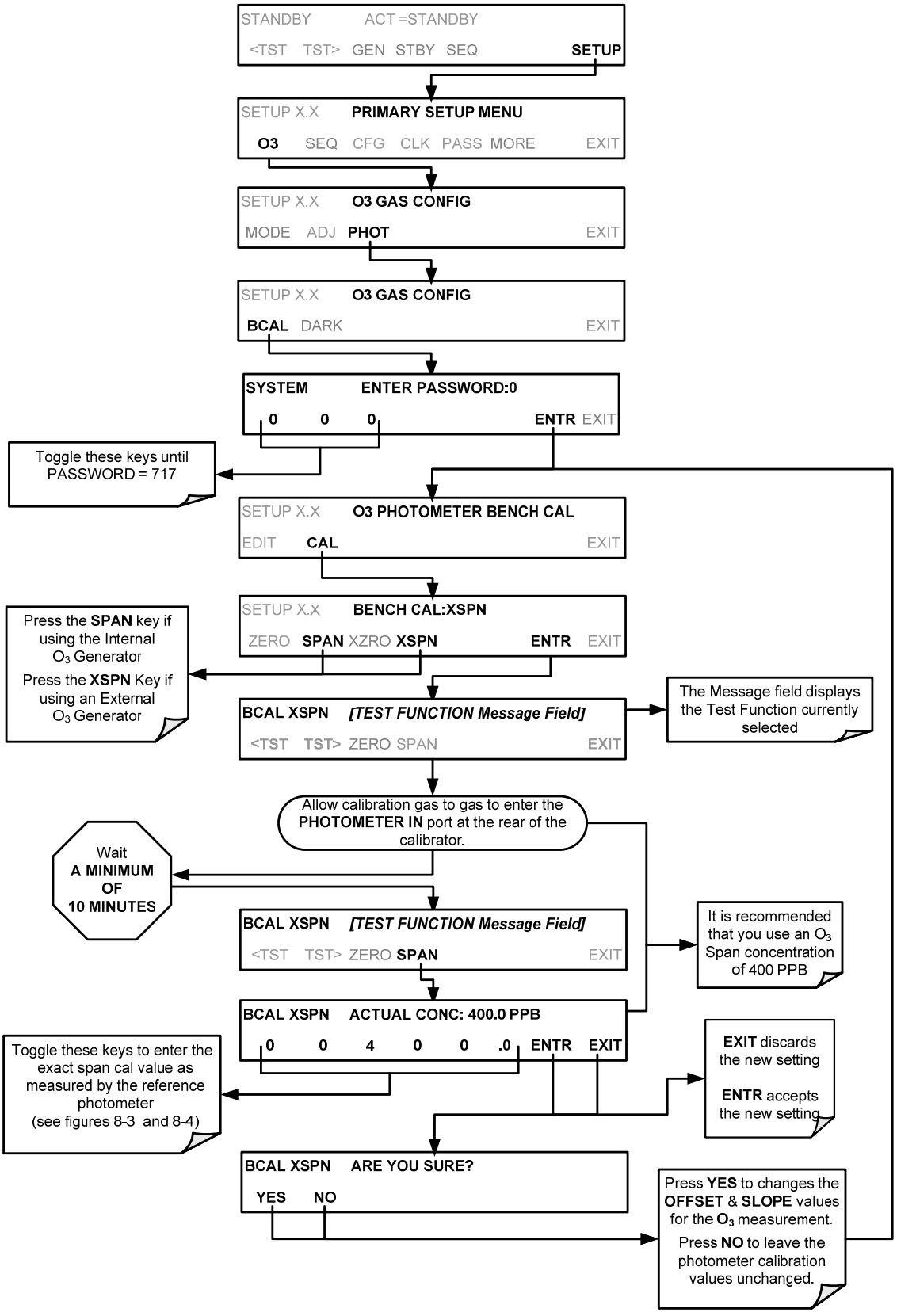
8.1.3.1. Photometer Zero Calibration

To set the zero point offset for the M703E Photometric Calibrator's photometer, press:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X O3 GAS CONFIG
MODE ADJ PHOT EXIT
SETUP X.X O3 GAS CONFIG
BCAL DARK EXIT
SYSTEM ENTER PASSWORD:0
0 0 0 ENTR EXIT
Toggle these keys until PASSWORD = 717
SETUP X.X O3 PHOTOMETER BENCH CAL
EDIT CAL EXIT
SETUP X.X BENCH CAL:XZRO
ZERO SPAN XZRO XSPN ENTR EXIT
Press the ZERO key if using the Internal O3 Generator
Press the XZRO Key if using an External O3 Generator
BCAL XZRO [TEST FUNCTION Message Field]
<TST TST> ZERO SPAN EXIT
The Message field displays the Test Function currently selected
Allow zero air to enter the PHOTOMETER IN port at the rear of the calibrator.
Wait A MINIMUM OF 10 MINUTES
BCAL XZRO [TEST FUNCTION Message Field]
<TST TST> ZERO EXIT
BCAL XZRO ARE YOU SURE?
YES NO
Press YES to changes the OFFSET & SLOPE values for the O3 measurement.
Press NO to leave the photometer calibration values unchanged.

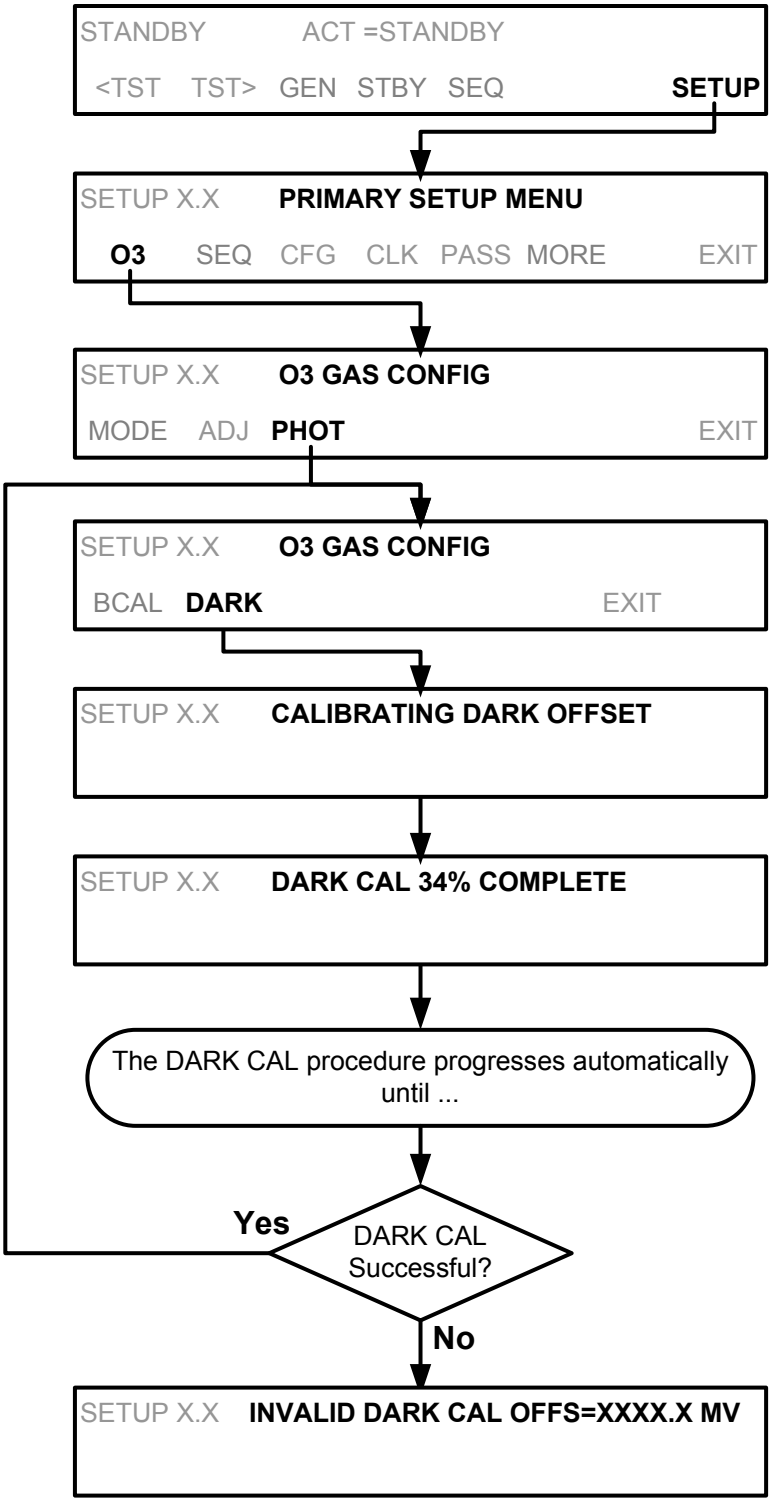
8.1.3.2. Photometer Span Calibration

To set the response SLOPE for the M703E Photometric Calibrator's photometer, press:


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X O3 GAS CONFIG
MODE ADJ PHOT EXIT
SETUP X.X O3 GAS CONFIG
BCAL DARK EXIT
SYSTEM ENTER PASSWORD:0
0 0 0 ENTR EXIT
Toggle these keys until PASSWORD = 717
SETUP X.X O3 PHOTOMETER BENCH CAL
EDIT CAL EXIT
SETUP X.X BENCH CAL:XSPN
ZERO SPAN XZRO XSPN ENTR EXIT
Press the SPAN key if using the Internal O3 Generator
Press the XSPN Key if using an External O3 Generator
BCAL XSPN [TEST FUNCTION Message Field]
<TST TST> ZERO SPAN EXIT
The Message field displays the Test Function currently selected
Allow calibration gas to gas to enter the PHOTOMETER IN port at the rear of the calibrator.
Wait A MINIMUM OF 10 MINUTES
BCAL XSPN [TEST FUNCTION Message Field]
<TST TST> ZERO SPAN EXIT
It is recommended that you use an O3 Span concentration of 400 PPB
BCAL XSPN ACTUAL CONC: 400.0 PPB
0 0 4 0 0 .0 ENTR EXIT
Toggle these keys to enter the exact span cal value as measured by the reference photometer (see figures 8-3 and 8-4)
EXIT discards the new setting
ENTR accepts the new setting
BCAL XSPN ARE YOU SURE?
YES NO
Press YES to changes the OFFSET & SLOPE values for the O3 measurement.
Press NO to leave the photometer calibration values unchanged.

8.1.4. O_3 PHOTOMETER DARK CALIBRATION

The Dark Calibration Test turns off the Photometer UV Lamp and records any offset signal level of the UV Detector-Preamp-Voltage to Frequency Converter circuitry. This allows the instrument to compensate for any voltage levels inherent in the Photometer detection circuit that might affect the output of the detector circuitry and therefore the calculation of O_3 concentration.


STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X O3 GAS CONFIG
MODE ADJ PHOT EXIT
SETUP X.X O3 GAS CONFIG
BCAL DARK EXIT
SETUP X.X CALIBRATING DARK OFFSET
SETUP X.X DARK CAL 34% COMPLETE
The DARK CAL procedure progresses automatically until ...
Yes
DARK CAL Successful?
No
SETUP X.X INVALID DARK CAL OFFS=XXXX.X MV

8.2. CALIBRATING THE O_3 GENERATOR

The M703E calibrator's software includes a routine for automatically calibrating the O_3 generator. A calibration table of drive voltages stored in the M703E's memory is the basis for this calibration. This table is used by the M703E to set initial O3 generator drive settings.

8.2.1. O3 GENERATOR CALIBRATION TABLE

When the M703E is operated in BENCH mode, this table is used for the initial setting only. After a short delay time, the bench feedback control will take over and control the O_3 generator drive to servo in to the exact concentration requested.

When the M703E is operated in CONST mode, the initial O_3 generator drive setting will be set by the calibration table and does not change.

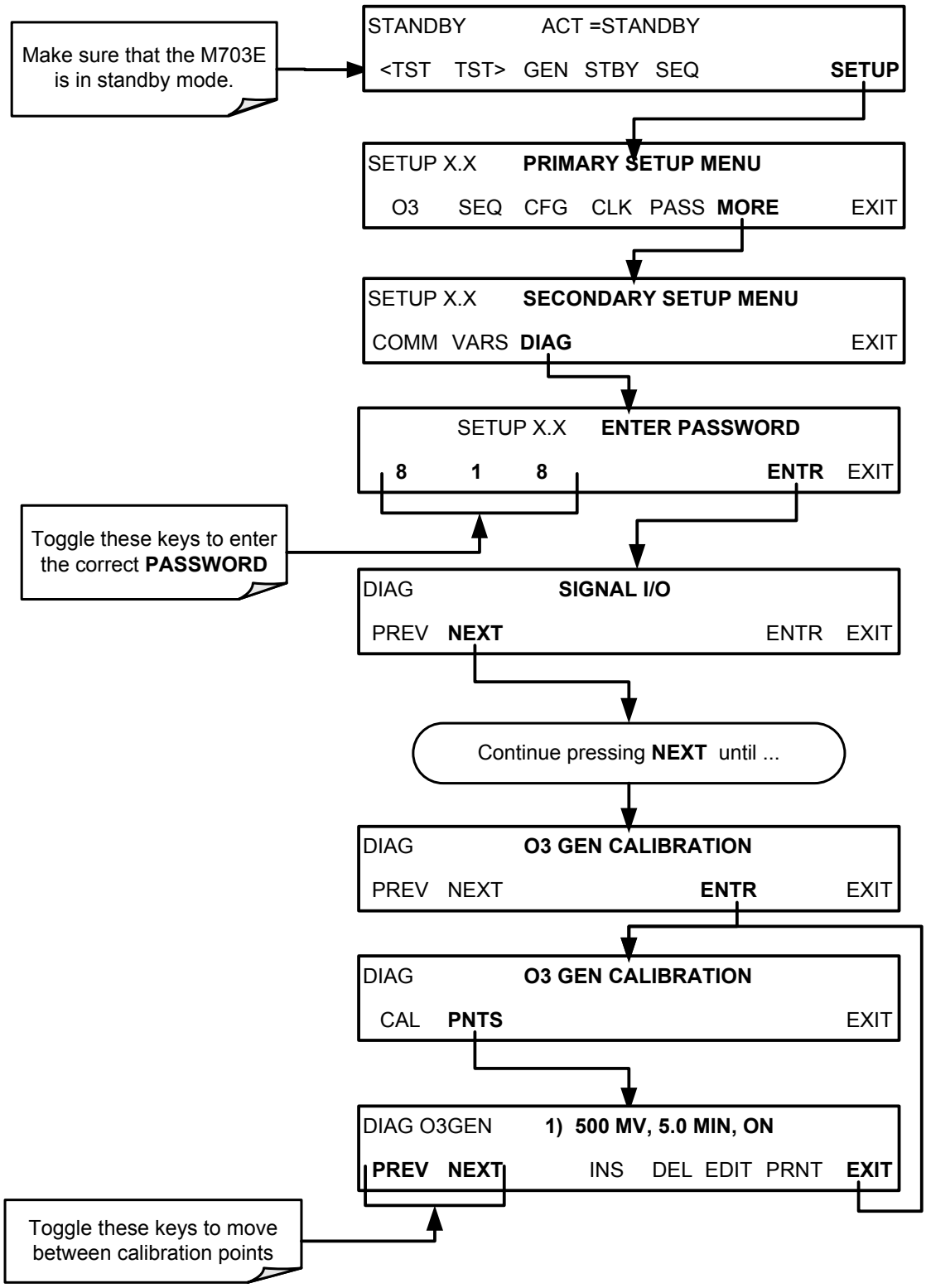
When the M703E is operated in REF mode, the calibration table sets the initial drive setting and then the reference detector feedback takes over to maintain the lamp at a constant intensity as measured by the reference detector. The target value for the reference detector for a particular target concentration is also stored in this calibration table.

The instrument software will interpolate between two values in the table when an intermediate concentration is requested.

For each point included in the table used by the M703E to calibrate the optional O_3 generator the user can set a drive voltage and a dwell time for that point. Each point can also be individually turned off or on.

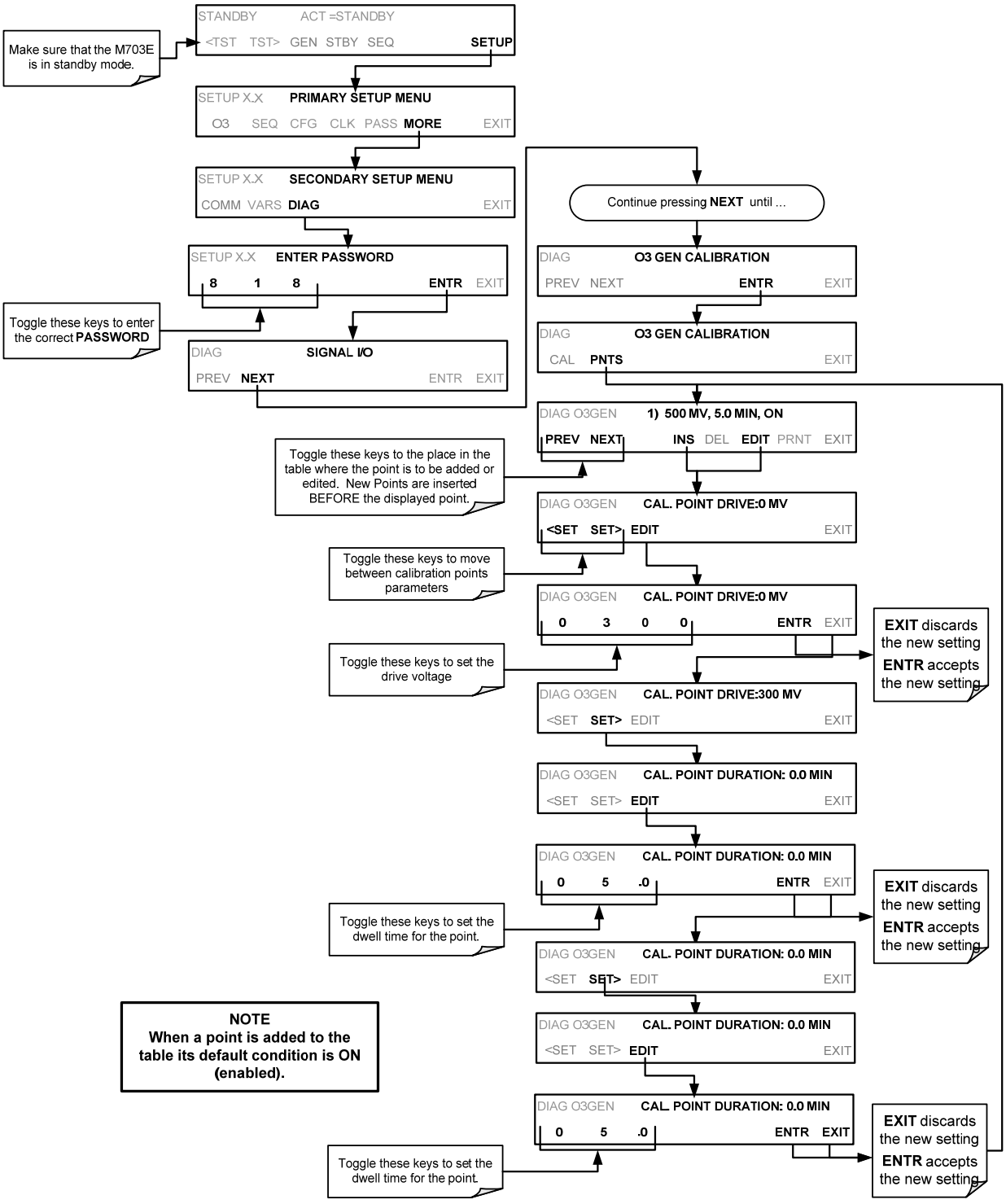
8.2.2. VIEWING O_3 GENERATOR CALIBRATION POINTS

To view these calibration points, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
Continue pressing NEXT until ...
DIAG O3 GEN CALIBRATION
PREV NEXT ENTR EXIT
DIAG O3 GEN CALIBRATION
CAL PNTS EXIT
DIAG O3GEN 1) 500 MV, 5.0 MIN, ON
PREV NEXT INS DEL EDIT PRNT EXIT
Toggle these keys to move between calibration points

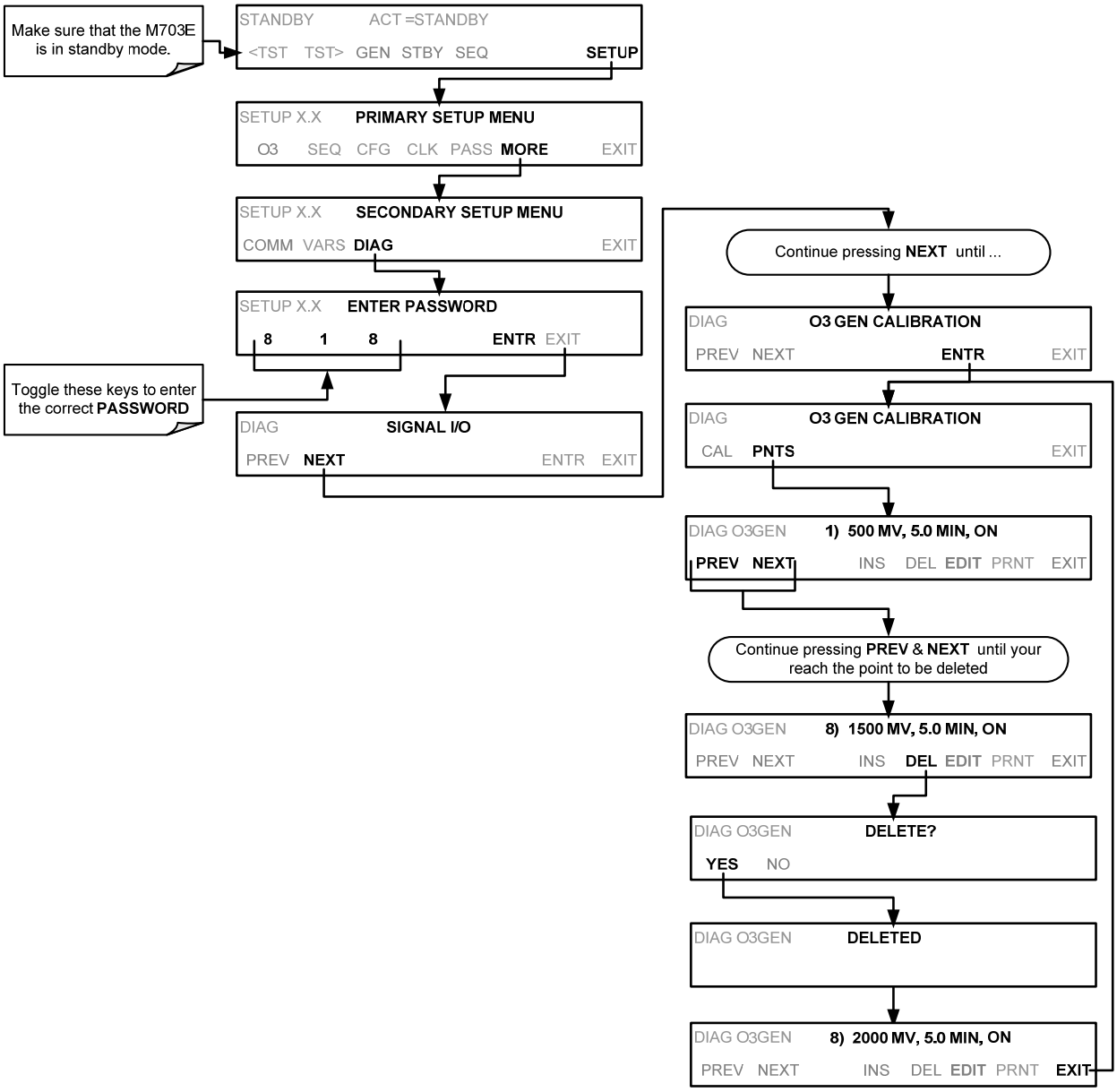
8.2.3. ADDING OR EDITING O_3 GENERATOR CALIBRATION POINTS

To add a calibration point to the table or edit an existing point, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
Continue pressing NEXT until ...
DIAG O3 GEN CALIBRATION
PREV NEXT ENTR EXIT
DIAG O3 GEN CALIBRATION
CAL PNTS EXIT
DIAG O3GEN 1) 500 MV, 5.0 MIN, ON
PREV NEXT INS DEL EDIT PRNT EXIT
Toggle these keys to the place in the table where the point is to be added or edited. New Points are inserted BEFORE the displayed point.
DIAG O3GEN CAL. POINT DRIVE:0 MV
<SET SET> EDIT EXIT
Toggle these keys to move between calibration points parameters
DIAG O3GEN CAL. POINT DRIVE:0 MV
0 3 0 0 ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle these keys to set the drive voltage
DIAG O3GEN CAL. POINT DRIVE:300 MV
<SET SET> EDIT EXIT
DIAG O3GEN CAL. POINT DURATION: 0.0 MIN
<SET SET> EDIT EXIT
DIAG O3GEN CAL. POINT DURATION: 0.0 MIN
0 5 .0 ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle these keys to set the dwell time for the point.
DIAG O3GEN CAL. POINT DURATION: 0.0 MIN
<SET SET> EDIT EXIT
DIAG O3GEN CAL. POINT DURATION: 0.0 MIN
<SET SET> EDIT EXIT
DIAG O3GEN CAL. POINT DURATION: 0.0 MIN
0 5 .0 ENTR EXIT
EXIT discards the new setting
ENTR accepts the new setting
Toggle these keys to set the dwell time for the point.
NOTE
When a point is added to the table its default condition is ON (enabled).

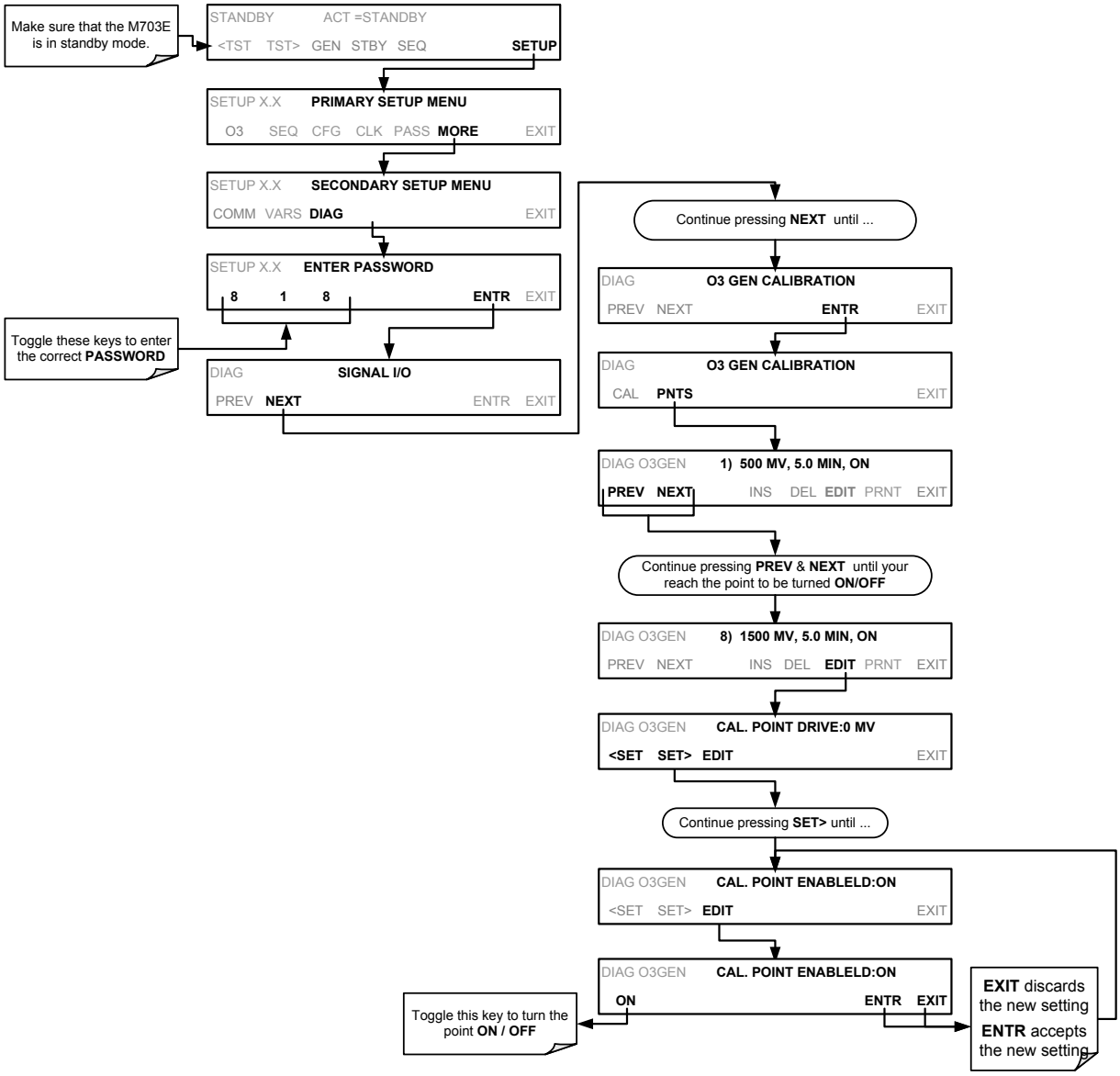
8.2.4. DELETING O_3 GENERATOR CALIBRATION POINTS

To delete an existing calibration point, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
Continue pressing NEXT until ...
DIAG O3 GEN CALIBRATION
PREV NEXT ENTR EXIT
DIAG O3 GEN CALIBRATION
CAL PNTS EXIT
DIAG O3GEN 1) 500 MV, 5.0 MIN, ON
PREV NEXT INS DEL EDIT PRNT EXIT
Continue pressing PREV & NEXT until your reach the point to be deleted
DIAG O3GEN 8) 1500 MV, 5.0 MIN, ON
PREV NEXT INS DEL EDIT PRNT EXIT
DIAG O3GEN DELETE?
YES NO
DIAG O3GEN DELETED
DIAG O3GEN 8) 2000 MV, 5.0 MIN, ON
PREV NEXT INS DEL EDIT PRNT EXIT

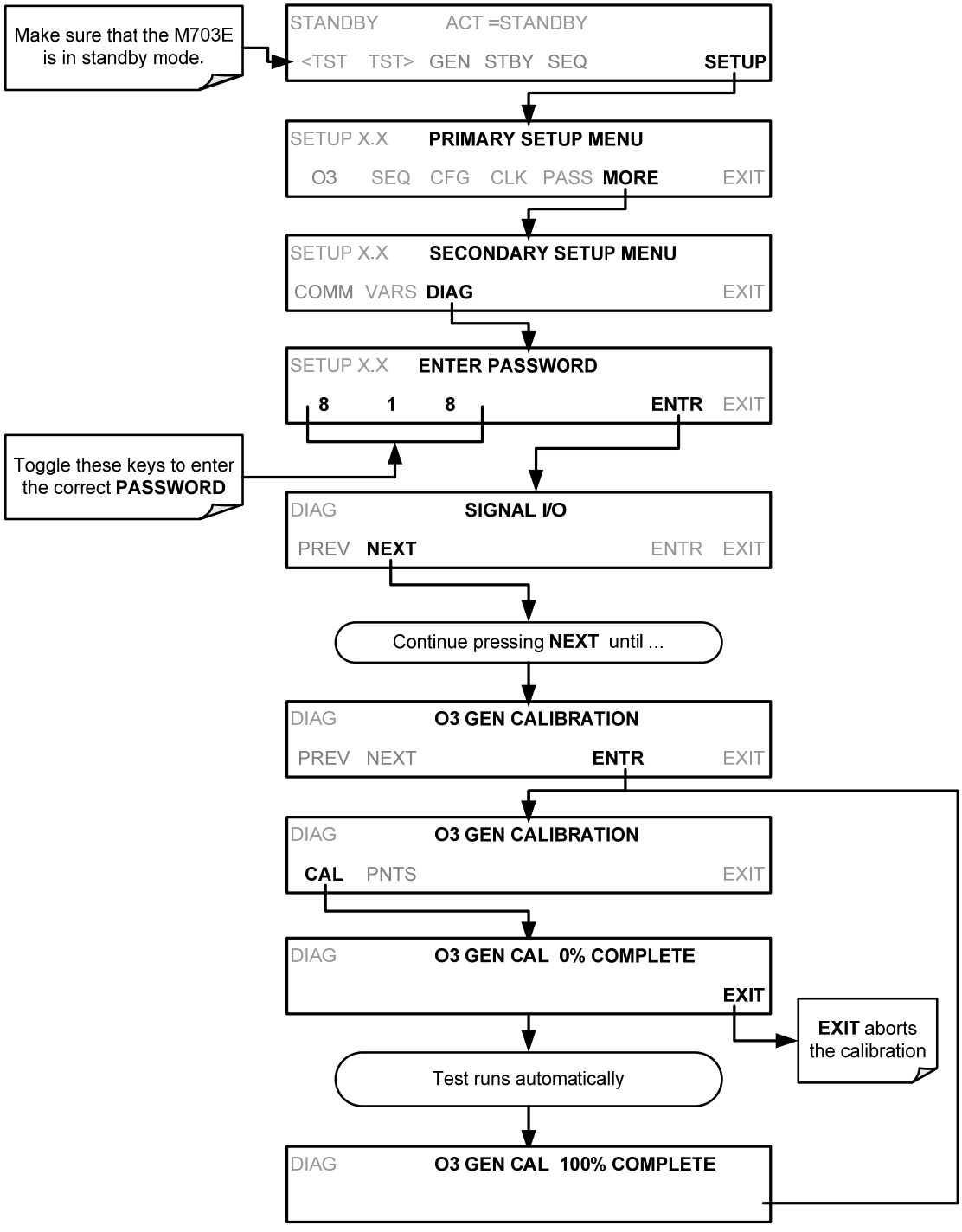
8.2.5. TURNING O_3 GENERATOR CALIBRATION POINTS ON / OFF

To enable or disable an existing calibration point, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
Continue pressing NEXT until ...
DIAG O3 GEN CALIBRATION
PREV NEXT ENTR EXIT
DIAG O3 GEN CALIBRATION
CAL PNTS EXIT
DIAG O3GEN 1) 500 MV, 5.0 MIN, ON
PREV NEXT INS DEL EDIT PRNT EXIT
Continue pressing PREV & NEXT until your reach the point to be turned ON/OFF
DIAG O3GEN 8) 1500 MV, 5.0 MIN, ON
PREV NEXT INS DEL EDIT PRNT EXIT
DIAG O3GEN CAL. POINT DRIVE:0 MV
<SET SET> EDIT EXIT
Continue pressing SET> until ...
DIAG O3GEN CAL. POINT ENABLELD:ON
<SET SET> EDIT EXIT
DIAG O3GEN CAL. POINT ENABLELD:ON
ON ENTR EXIT
Toggle this key to turn the point ON / OFF
EXIT discards the new setting
ENTR accepts the new setting

8.2.6. PERFORMING AN AUTOMATIC CALIBRATION OF THE O_3 GENERATOR

To run the automatic O_3 generator calibration program, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
Continue pressing NEXT until ...
DIAG O3 GEN CALIBRATION
PREV NEXT ENTR EXIT
DIAG O3 GEN CALIBRATION
CAL PNTS EXIT
DIAG O3 GEN CAL 0% COMPLETE
EXIT
EXIT aborts the calibration
Test runs automatically
DIAG O3 GEN CAL 100% COMPLETE

8.3. M703E GAS PRESSURE SENSOR CALIBRATION

The M703E Calibrator has two sensors that monitor the pressure of the gases flowing through the instrument. The data collected by these sensors is used to compensate the final concentration calculations for changes in atmospheric pressure and is stored in the CPU's memory as test functions:

Table 8-1: M703E Pressure Sensors

SENSOR	ASSOCIATED TEST FUNCTION	UNITS	PRESSURE MONITOR MEASUREMENT POINT
Regulator Pressure Sensor	**REG PRESSURE**	**PSIG**	Capped fitting on backside of regulator assembly. See Figure 8-4
Photometer Sample Gas Pressure Sensor	**PHOTO SPRESS**	**IN-HG-A**	Use monitor to measure ambient atmospheric pressure at the calibrator's location.

8.3.1.1. Gas Pressure Sensor Calibration Set Up

The procedures described in this section require an independent, calibrated pressure meter/monitor be attached at the following location.

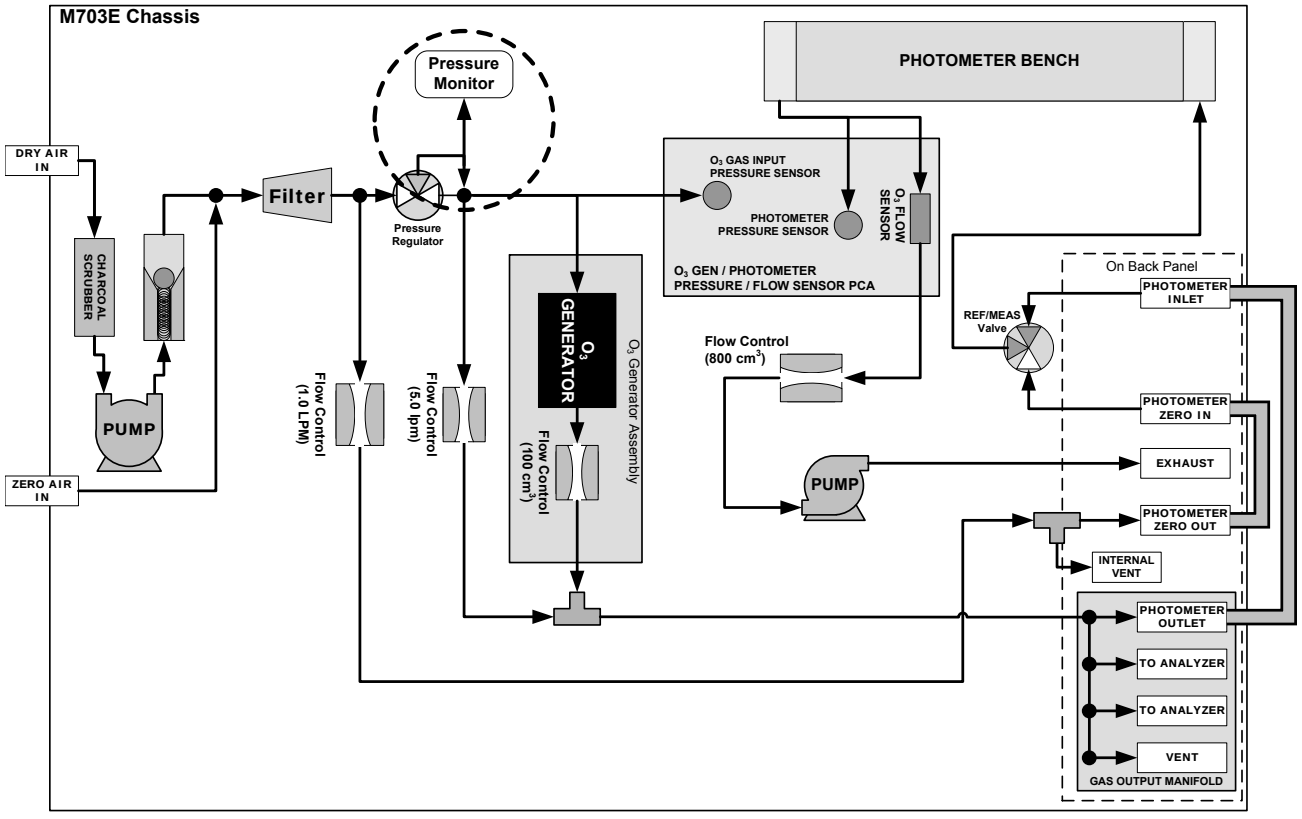


Figure 8-3: Pressure Calibration Monitor Points

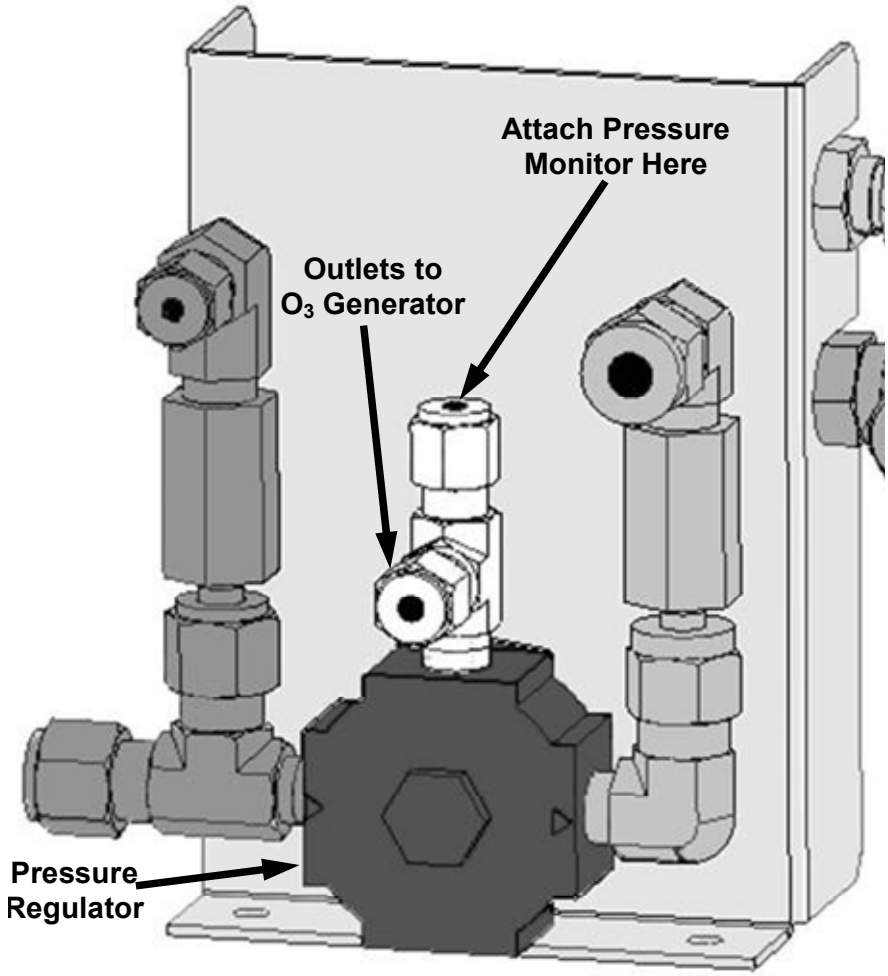
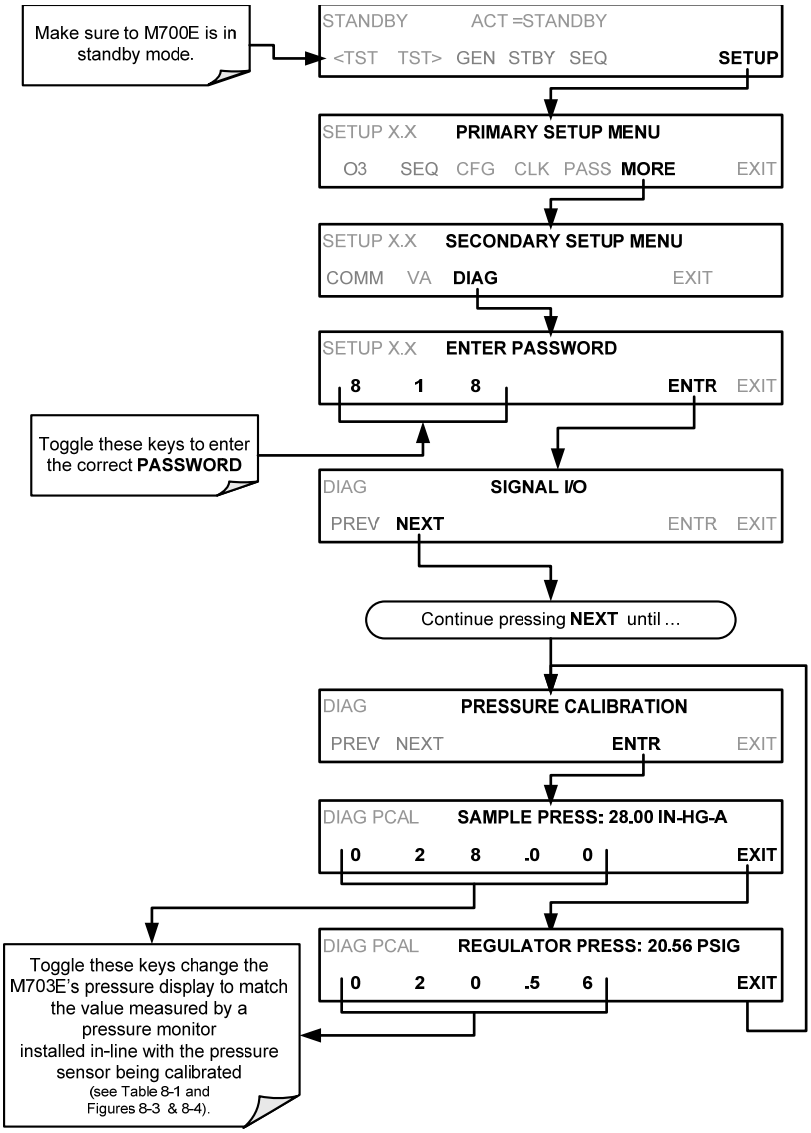


Figure 8-4: O_3 Generator Pressure Monitor Point Physical Location– M703E

8.3.2. CALIBRATING THE REGULATOR AND PHOTOMETER PRESSURE SENSORS

1. Turn off the calibrator and open the top cover.
2. Connect a pressure meter to the Regulator Pressure measurement fitting. This fitting is located on the backside of the regulator assembly (see Figure 8-4).
3. Turn on the calibrator and perform the following steps:


Make sure to M700E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VA DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
Continue pressing NEXT until …
DIAG PRESSURE CALIBRATION
PREV NEXT ENTR EXIT
DIAG PCAL SAMPLE PRESS: 28.00 IN-HG-A
0 2 8 .0 0 EXIT
DIAG PCAL REGULATOR PRESS: 20.56 PSIG
0 2 0 .5 6 EXIT
Toggle these keys change the M703E's pressure display to match the value measured by a pressure monitor installed in-line with the pressure sensor being calibrated
(see Table 8-1 and Figures 8-3 & 8-4).

4. Turn OFF the M703E, remove the pressure monitor, replace the cap on the pressure measurement fitting.

8.4. M703E GAS FLOW CALIBRATION

The M703E has two gas flow characteristics that affect its performance: the flow of gas thought the sample chamber of the instrument's photometer and the total gas flow being output. While both are stored in the calibrator's memory and used to compensate the final concentration calculations for changes in atmospheric pressure, they are calculated quite differently.

PHOTOMETER SAMPLE GAS FLOW RATE:

This flow rate is measured directly by a flow sensor located pressure / flow sensor PCA. A slope factor, stored in the calibrator's memory the last time a **PHOTO FLOW** calibration operation (see Section 8.4.1) was performed, is and applied to the reading from that sensor.

The calculated photometer sample gas flow value is viewable on the instrument's front panel using the **PHOTO FLOW** test function and can be output via the M703E's **TEST CHANNEL** output using the **SAMPLE FLOW** function.

OUTPUT GAS FLOW RATE:

This flow rate is calculated by applying a separate slope factor, also stored in the calibrator's memory, to an interpolated valued based on the following table of internal gas pressure as measured by the O_3 gas input pressure sensor. The output-flow slope value is determined by performing an **OUPUT FLOW** calibration operation (see Section 8.4.2).

Table 8-2: M703E Gas Pressure to Output Flow conversion Table

M703E REGULATOR PRESSURE TO OUTPUT FLOW	
PSIG	**LPM**
0	0.000
1	0.676
2	1.214
3	1.659
4	2.071
5	2.463
6	2.816
7	3.178
8	3.536
9	3.851
10	4.166
15	5.744
20	7.282
25	8.755
30	10.254
35	11.695
40	13.146

The calculated **OUTPUT FLOW** value is viewable on the instrument's front panel using the **OUTPUT FLOW** test function and can be output via the M703E's **TEST CHANNEL** using the **OUTPUT FLOW** function.

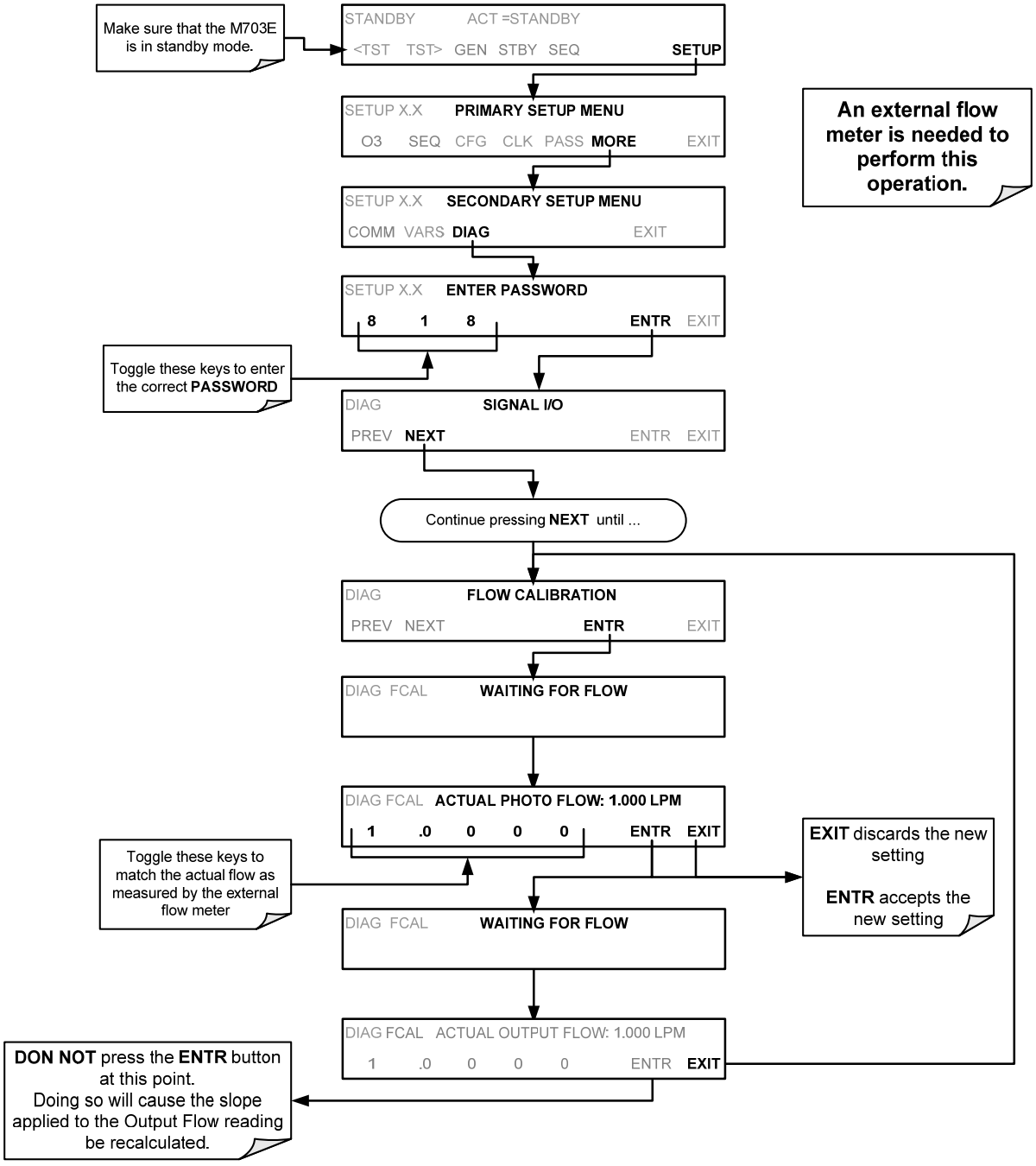
8.4.1. CALIBRATING THE PHOTOMETER'S SAMPLE GAS FLOW

NOTE

The procedure described in this section requires an independent, calibrated gas flow meter/monitor be connected to the EXHAUST fitting on the back of the M703E.

During the **PHOTO FLOW** calibration, the M703E software automatically turns the DC pump downstream from the photometer **ON**.

To perform a **PHOTO FLOW** calibration, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
Continue pressing NEXT until ...
DIAG FLOW CALIBRATION
PREV NEXT ENTR EXIT
DIAG FCAL WAITING FOR FLOW
DIAG FCAL ACTUAL PHOTO FLOW: 1.000 LPM
1 .0 0 0 0 ENTR EXIT
Toggle these keys to match the actual flow as measured by the external flow meter
EXIT discards the new setting
ENTR accepts the new setting
DIAG FCAL WAITING FOR FLOW
DIAG FCAL ACTUAL OUTPUT FLOW: 1.000 LPM
1 .0 0 0 0 ENTR EXIT
DON NOT press the ENTR button at this point.
Doing so will cause the slope applied to the Output Flow reading be recalculated.
An external flow meter is needed to perform this operation.

8.4.2. CALIBRATING THE OUTPUT GAS FLOW

8.4.2.1. Output Gas Flow Set Up

The procedure described in this section requires an independent, calibrated flow meter/monitor and the following set up:

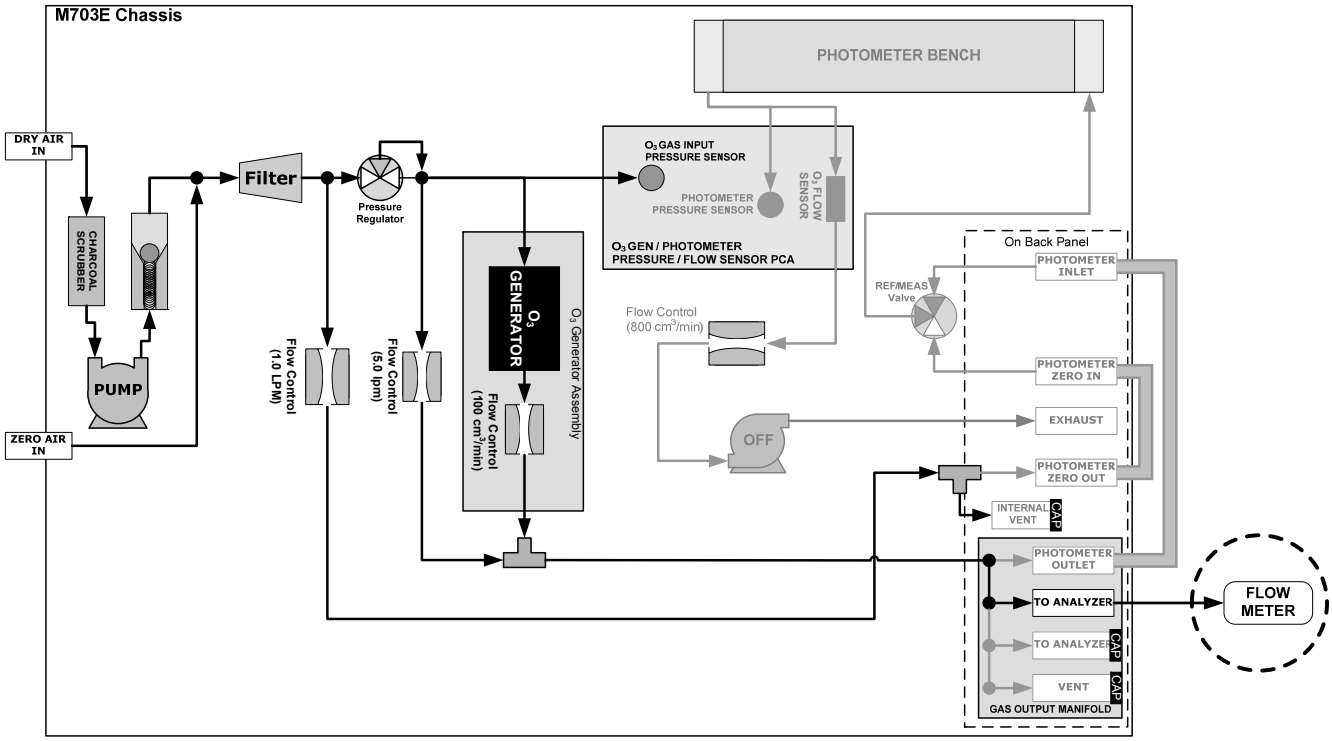
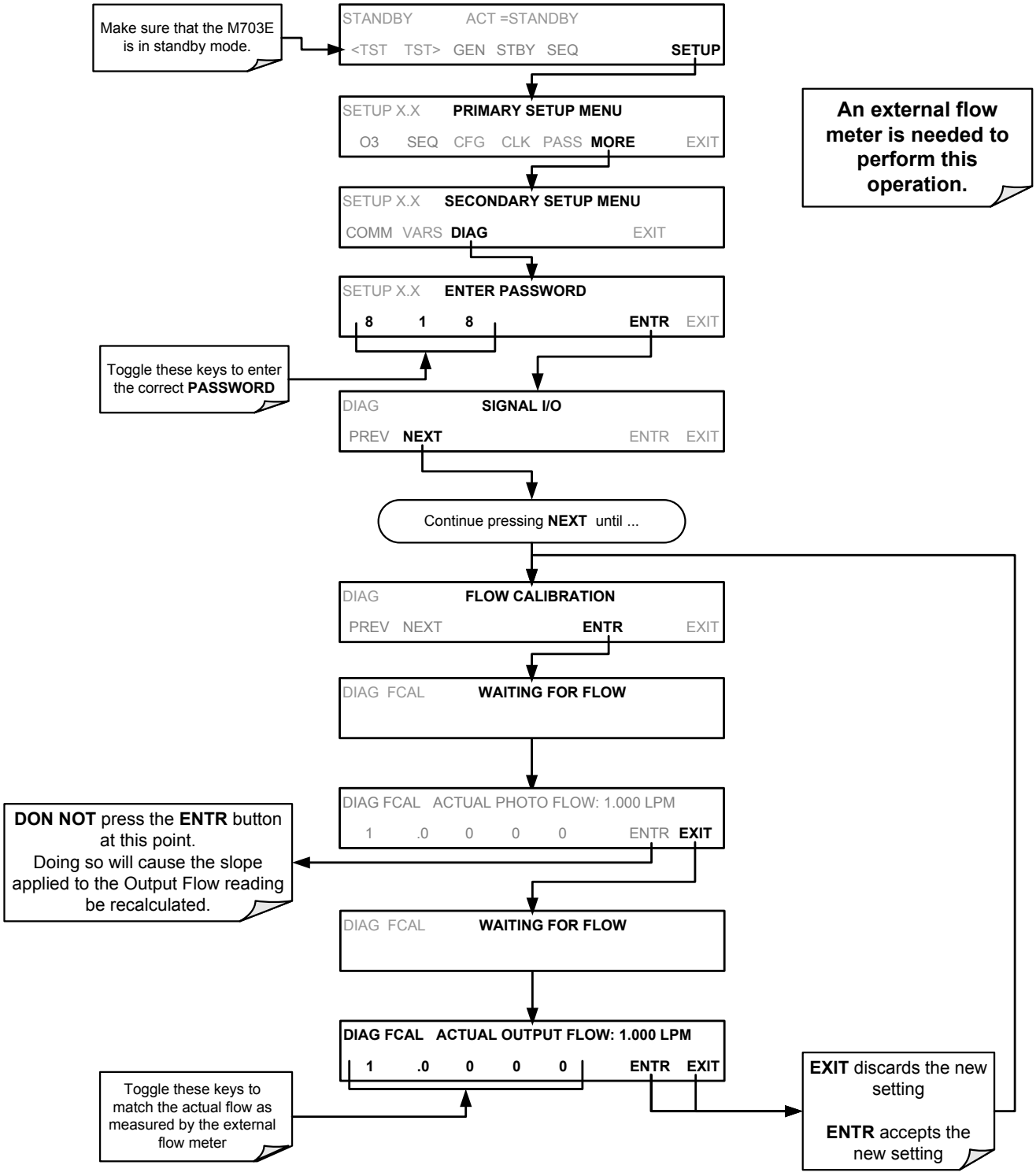


Figure 8-5: Output Flow Calibration Monitor Point

8.4.2.2. Performing an Output Gas Flow Calibration

During the **PHOTO FLOW** calibration, the M703E software automatically turns the DC pump downstream from the photometer **OFF** and the AC dry air pump **ON**. To perform a **PHOTO FLOW** calibration, press:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
An external flow meter is needed to perform this operation.
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
Continue pressing NEXT until ...
DIAG FLOW CALIBRATION
PREV NEXT ENTR EXIT
DIAG FCAL WAITING FOR FLOW
DIAG FCAL ACTUAL PHOTO FLOW: 1.000 LPM
1 .0 0 0 0 ENTR EXIT
DON NOT press the ENTR button at this point.
Doing so will cause the slope applied to the Output Flow reading be recalculated.
DIAG FCAL WAITING FOR FLOW
DIAG FCAL ACTUAL OUTPUT FLOW: 1.000 LPM
1 .0 0 0 0 ENTR EXIT
Toggle these keys to match the actual flow as measured by the external flow meter
EXIT discards the new setting
ENTR accepts the new setting

USER NOTES:

SECTION III
–
TECHNICAL INFORMATION

USER NOTES:

9. THEORY OF OPERATION

9.1. PNEUMATIC OPERATION

9.1.1. GAS FLOW CONTROL

Gas flow rates are set by various flow control assemblies located in the gas stream(s).

9.1.1.1. Flow Control Assemblies

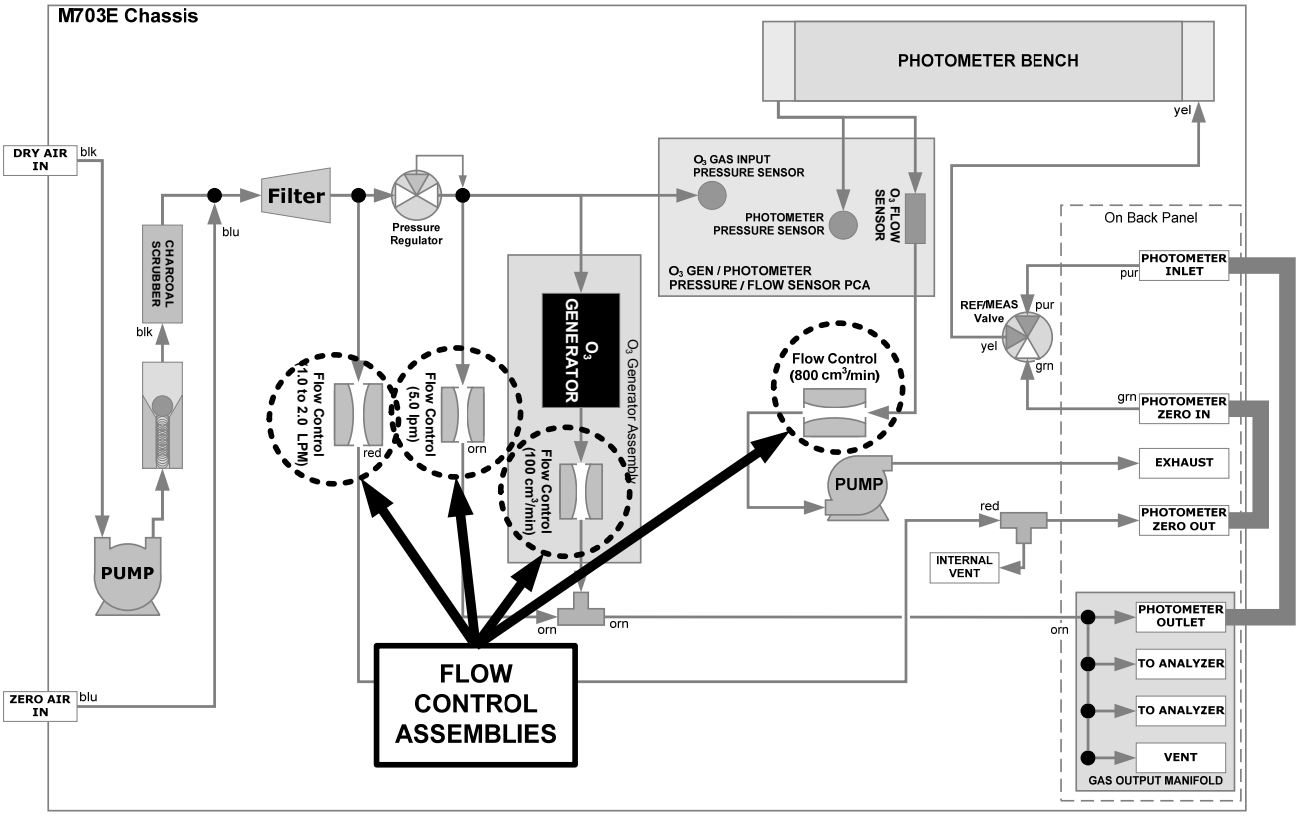


Figure 9-1: Location of Gas Flow Control Assemblies

9.1.1.2. Photometer Critical Flow Orifice

Critical flow orifices are a remarkably simple way to regulate stable gas flow rates. They operate without moving parts by taking advantage of the laws of fluid dynamics. By restricting the flow of gas though the orifice, a pressure differential is created. This pressure differential combined with the action of the calibrator's pump draws the gas through the orifice.

As the pressure on the downstream side of the orifice (the pump side) continues to drop, the speed that the gas flows though the orifice continues to rise. Once the ratio of upstream pressure to downstream pressure is greater than 2:1, the velocity of the gas through the orifice reaches the speed of sound. As long as that ratio

stays at least 2:1 the gas flow rate is unaffected by any fluctuations, surges, or changes in downstream pressure because such variations only travel at the speed of sound themselves and are therefore cancelled out by the sonic shockwave at the downstream exit of the critical flow orifice.

The actual flow rate of gas through the orifice (volume of gas per unit of time), depends on the size and shape of the aperture in the orifice. The larger the hole, the more gas molecules, moving at the speed of sound, pass through the orifice.

9.1.2. INTERNAL GAS PRESSURE SENSORS

There are two pressure sensors in the M703E. See Figure 3-3 for the location of the Pressure/Flow PCA.

A 100 psig pressure sensor on this PCA is used to monitor the downstream regulator pressure. This value is displayed on the front panel as a test measurement called **REG PRESSURE**.

A second pressure located on the rear PCA measures the pressure of gas in the photometer's absorption tube. This sensor is a 0-15 psia (absolute pressure) range sensor. This data is used by the CPU when calculating the O_3 concentration inside the absorption tube. This value is displayed on the front panel as a test measurement called **PHOTO SPRESS**. Note that this value is converted to units of Inches of Mercury (IN-HG-A) when displayed on the front panel.

9.2. ELECTRONIC OPERATION

9.2.1. OVERVIEW

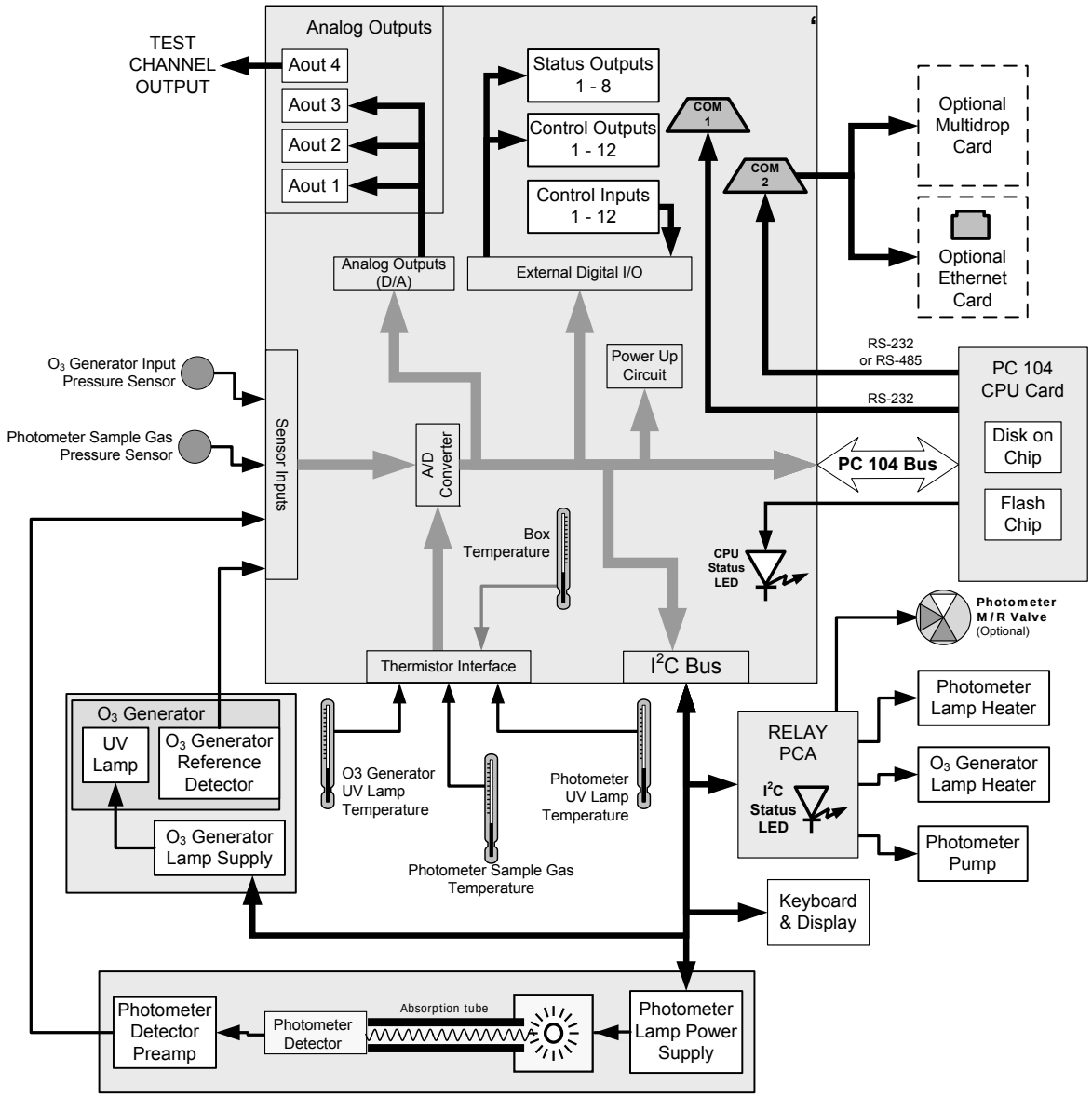


Figure 9-2: M703E Electronic Block Diagram

At its heart, the calibrator is a microcomputer (CPU) that controls various internal processes, interprets data, makes calculations, and reports results using specialized firmware developed by Teledyne Instruments. It communicates with the user as well as receives data from and issues commands to a variety of peripheral devices via a separate printed circuit assembly called the Mother Board.

The motherboard collects data, performs signal conditioning duties and routs incoming and outgoing signals between the CPU and the calibrator's other major components.

Data is generated by the various sub components of the M703E (e.g. flow data from the MFC's, O_3 concentration from the optional photometer). Analog signals are converted into digital data by a unipolar, analog-to-digital converter, located on the motherboard.

A variety of sensors report the physical and operational status of the calibrator's major components, again through the signal processing capabilities of the motherboard. These status reports are used as data for the concentration calculations and as trigger events for certain control commands issued by the CPU. They are stored in memory by the CPU and in most cases can be viewed but the user via the front panel display.

The CPU communicates with the user and the outside world in a variety of manners:

- Through the calibrator's keyboard and vacuum florescent display over a clocked, digital, serial I/O bus (using a protocol called I2C);
- RS 232 & RS485 serial I/O channels;
- Via an optional Ethernet communications card:
- Various digital and analog outputs, and
- A set of digital control input channels.

Finally, the CPU issues commands via a series of relays and switches (also over the I^2C bus) located on a separate printed circuit assembly to control the function of key electromechanical devices such as heaters, motors and valves.

9.2.2. CPU

The CPU is a low power (5 VDC, 0.8A max), high performance, 386-based microcomputer running a version of the DOS operating system. Its operation and assembly conform to the PC-104 specification, version 2.3 for embedded PC and PC/AT applications. It has 2 MB of DRAM memory on board and operates at 40 MHz clock rate over an internal, 32-bit data and address bus. Chip to chip data handling is performed by two 4-channel, direct memory access (DMA) devices over data busses of either 8-bit or 16-bit bandwidth. The CPU supports both RS-232 and RS-485 serial protocols. Figure 9-3 shows the CPU board.

- The CPU communicates with the user and the outside world in a variety of ways:
- Through the calibrator's keyboard and vacuum fluorescence display over a clocked, digital, serial I/O bus using the I^2C protocol (read *I-square-C bus*)
- RS-232 and/or RS-485 serial ports (one of which can be connected to an Ethernet converter)
- Various analog voltage and current outputs
- Several digital I/O channels

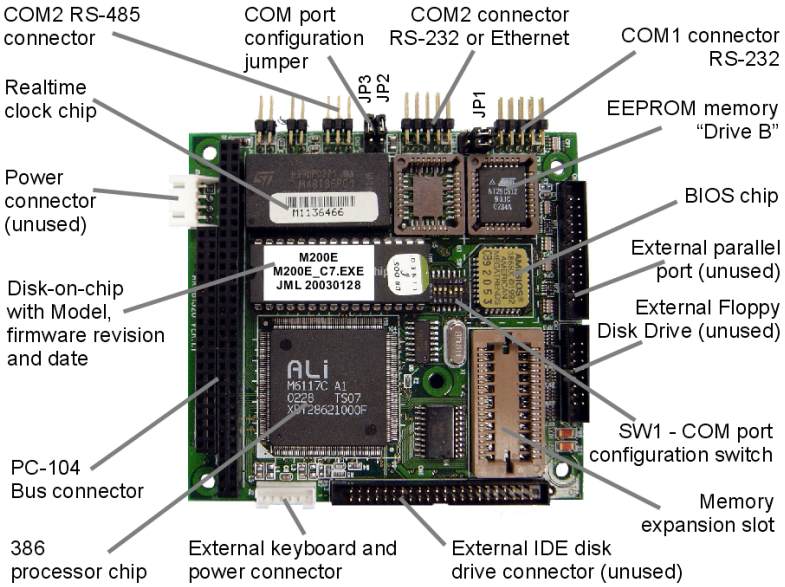


Figure 9-3: M703E CPU Board Annotated

Finally, the CPU issues commands (also over the I2C bus) to a series of relays and switches located on a separate printed circuit assembly, the relay board (located in the right rear of the chassis on its own mounting bracket) to control the function of heaters and valves. The CPU includes two types of non-volatile data storage, one disk-on-chip and one or two flash chips.

9.2.2.1. Disk On Chip

Technically, the disk-on-chip is an EEPROM, but appears to the CPU as, behaves as, and performs the same functions in the system as an 8 mb disk drive, internally labeled as DOS drive C:\. It is used to store the computer's operating system files, the Teledyne Instruments firmware and peripheral files, and the operational data generated by the calibrator's internal data acquisition system.

9.2.2.2. Flash Chip

The flash chip is another, smaller EEPROM with about 64 kb of space, internally labeled as DOS drive B:\. The M703E CPU board can accommodate up to two EEPROM flash chips. The M703E standard configuration is one chip with 64 kb of storage capacity, which is used to store the calibrator configuration as created during final checkout at the factory. Separating these data onto a less frequently accessed chip significantly decreases the chance of data corruption through drive failure.

In the unlikely event that the flash chip should fail, the calibrator will continue to operate with just the DOC. However, all configuration information will be lost, requiring the unit to be recalibrated.

9.2.3. RELAY PCA

The relay board is one of the central switching and power distribution units of the calibrator. It contains power relays, valve drivers and status LEDs for all heated zones and valves, as well as thermocouple amplifiers, power distribution connectors and the two switching power supplies of the calibrator. The relay board communicates with the motherboard over the I^2C bus. Its status indicators and components can be used for troubleshooting power problems and valve or heater functionality.

Generally, the relay PCA is located in the right-rear quadrant of the calibrator and is mounted vertically on the backside of the same bracket as the instrument's DC power supplies, however the exact location of the relay PCA may differ from model to model (see Figure 3-3.)

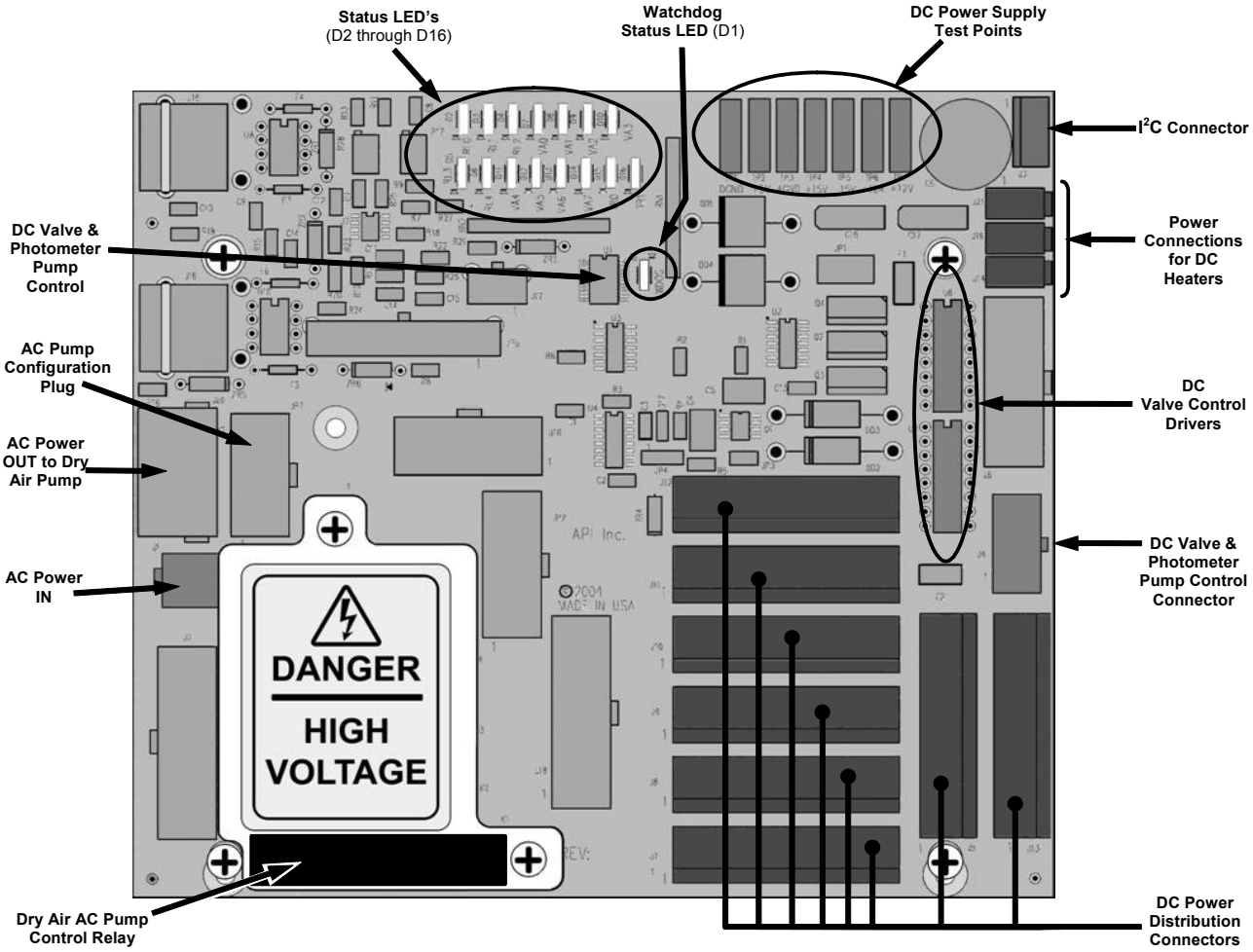


Figure 9-4: Relay Board PCA with AC Relay Retainer Removed

This version of the Relay PCA include one AC relays that controls the AC-powered Dry Air (zero air) pump and A plastic insulating safety shield covers the remaining empty AC Relay sockets.

	CAUTION **NEVER REMOVE THIS SAFETY SHIELD WHILE THE INSTRUMENT IS PLUGGED IN AND TURNED ON. THE CONTACTS OF THE AC RELAY SOCKETS BENEATH THE SHIELD CARRY HIGH AC VOLTAGES EVEN WHEN NO RELAYS ARE PRESENT**

9.2.3.1. Valve Control

The relay board also hosts two valve driver IC's, each of which can drive up four valves. In the M703E, the relay PCA controls only those valves associated with the O_3 generator and photometer options.

9.2.3.2. Heater Control

The relay PCA controls the DC heaters for the O_3 generator and photometer lamp housing.

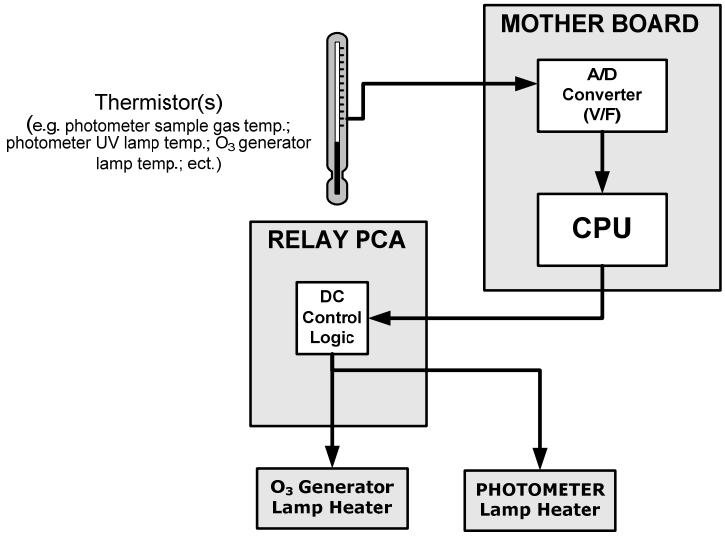


Figure 9-5: Heater Control Loop Block Diagram.

9.2.3.3. Relay PCA Status LEDs & Watch Dog Circuitry

Thirteen LEDs are located on the calibrator's relay board to indicate the status of the calibrator's heating zones and some of its valves as well as a general operating watchdog indicator. Table 11-2 shows the states of these LEDs and their respective functionality.

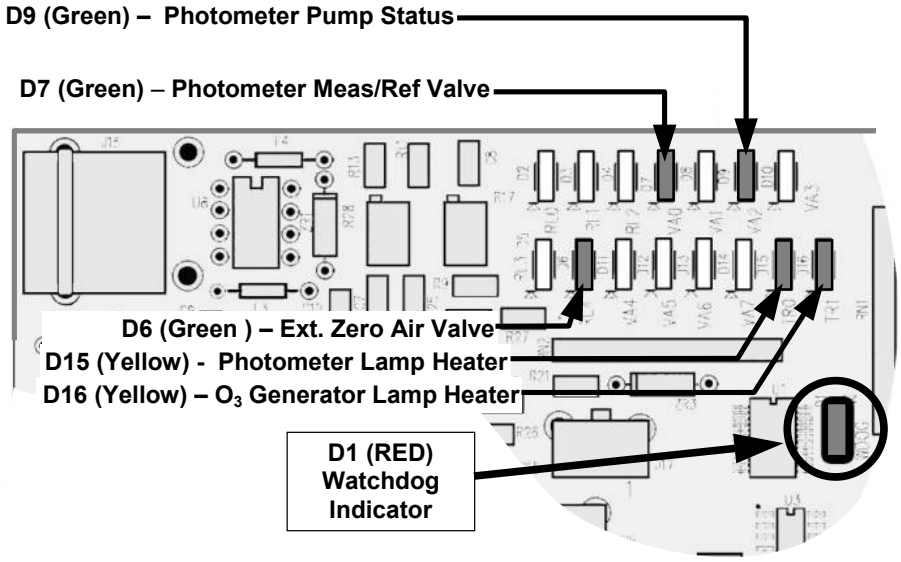

D9 (Green) – Photometer Pump Status
D7 (Green) – Photometer Meas/Ref Valve
D6 (Green) – Ext. Zero Air Valve
D15 (Yellow) - Photometer Lamp Heater
D16 (Yellow) – O3 Generator Lamp Heater
D1 (RED) Watchdog Indicator

Figure 9-6: Status LED Locations – Relay PCA

Table 9-1: Relay Board Status LEDs

LED	COLOR	DESCRIPTION	FUNCTION
D1	Red	Watchdog Circuit; I^2C bus operation.	Blinks when I^2C bus is operating properly
D2	Yellow	Dry Air Pump Status	When lit the zero air AC pump is running.
D3-6	SPARE		
D7	Green	Photometer Meas/Ref Valve	When lit the valve open to REFERENCE gas path
D8	SPARE		
D9	Green	Ext. Zero Air valve Status	When lit the External Zero Air valve is open
D10 - 14	SPARE		
D15	Yellow	Photometer Heater Status	When lit the photometer UV lamp heater is on
D16	Yellow	O_3 Generator Lamp Heater	When lit the O_3 generator UV lamp heater is on

9.2.3.4. Relay PCA Watchdog Indicator (D1)

The most important of the status LEDs on the relay board is the red I^2C Bus watchdog LED. It is controlled directly by the calibrator's CPU over the I^2C bus. Special circuitry on the relay PCA watches the status of D1. Should this LED ever stay ON or OFF for 30 seconds (indicating that the CPU or I^2C bus has stopped functioning) this Watchdog Circuit automatically shuts all valves and turns off all heaters and lamps.

9.2.4. MOTHERBOARD

This is the largest electronic assembly in the calibrator and is mounted to the rear panel as the base for the CPU board and all I/O connectors. This printed circuit assembly provides a multitude of functions including A/D conversion, digital input/output, PC-104 to I^2C translation, temperature sensor signal processing and is a pass through for the RS-232 and RS-485 signals.

9.2.4.1. A to D Conversion

Analog signals, such as the voltages received from the calibrator's various sensors, are converted into digital signals that the CPU can understand and manipulate by the analog to digital converter (A/D).Under the control of the CPU, this functional block selects a particular signal input and then coverts the selected voltage into a digital word.

The A/D consists of a voltage-to-frequency (V-F) converter, a programmable logic device (PLD), three multiplexers, several amplifiers and some other associated devices. The V-F converter produces a frequency proportional to its input voltage. The PLD counts the output of the V-F converter during a specified time period, and sends the result of that count, in the form of a binary number, to the CPU.

The A/D can be configured for several different input modes and ranges but in the M703E it is used in uni-polar mode with a +5V full scale. The converter includes a 1% over and under-range. This allows signals from -0.05V to +5.05V to be fully converted.

For calibration purposes, two reference voltages are supplied to the A/D converter: Reference ground and +4.096 VDC. During calibration, the device measures these two voltages, outputs their digital equivalent to the CPU. The CPU uses these values to compute the converter's offset and slope and also uses these factors for subsequent conversions.

9.2.4.2. Sensor Inputs

The key analog sensor signals are coupled to the A/D converter through the master multiplexer from two connectors on the motherboard. Terminating resistors (100 kΩ) on each of the inputs prevent cross talk between the sensor signals.

9.2.4.3. Thermistor Interface

This circuit provides excitation, termination and signal selection for several negative-coefficient, thermistors (temperature sensors) located inside the calibrator.

9.2.4.4. Analog Outputs

The M703E calibrator comes equipped with one analog output. It can be set by the user to carry the current signal level of any one of the parameters (see Table 7-4) and will output an analog VDC signal that rises and falls in relationship with the value of the parameter.

9.2.4.5. External Digital I/O

The external digital I/O performs two functions.

The **STATUS** outputs carry logic-level (5V) signals through an optically isolated 8-pin connector on the rear panel of the calibrator. These outputs convey on/off information about certain calibrator conditions such as **CONC VALID**. They can be used to interface with certain types of programmable devices.

The **CONTROL** outputs can be used to initiate actions by external peripheral devices in conjunction with individual steps of a calibration sequence (see Section 6.5.1.6).

The **CONTROL** inputs can be initiated by applying 5V DC power from an external source such as a PLC or data logger (Section 6.5.1.5). Zero and span calibrations can be initiated by contact closures on the rear panel.

9.2.4.6. I^2C Data Bus

I^2C is a two-wire, clocked, digital serial I/O bus that is used widely in commercial and consumer electronic systems. A transceiver on the motherboard converts data and control signals from the PC-104 bus to I^2C. The data are then fed to the keyboard/display interface and finally onto the relay board.

Interface circuits on the keyboard/display interface and relay board convert the I^2C data to parallel inputs and outputs. An additional interrupt line from the keyboard to the motherboard allows the CPU to recognize and service key strokes on the keyboard.

9.2.4.7. Power-up Circuit

This circuit monitors the +5V power supply during calibrator start-up and sets the analog outputs, external digital I/O ports, and I^2C circuitry to specific values until the CPU boots and the instrument software can establish control.

9.2.5. POWER SUPPLY AND CIRCUIT BREAKER

The M703E calibrator operates in two main AC power ranges: 100-120 VAC and 220-240 VAC (both ± 10%) between 47 and 63 Hz. A 5 ampere circuit breaker is built into the ON/OFF switch. In case of a wiring fault or incorrect supply power, the circuit breaker will automatically turn off the calibrator.

NOTE:

The M703E calibrator is equipped with a universal power supply that allows it to accept any AC power configuration, within the limits specified in Table 2-2.

CAUTION
Should the power circuit breaker trip correct the condition causing this situation before turning the calibrator back on.

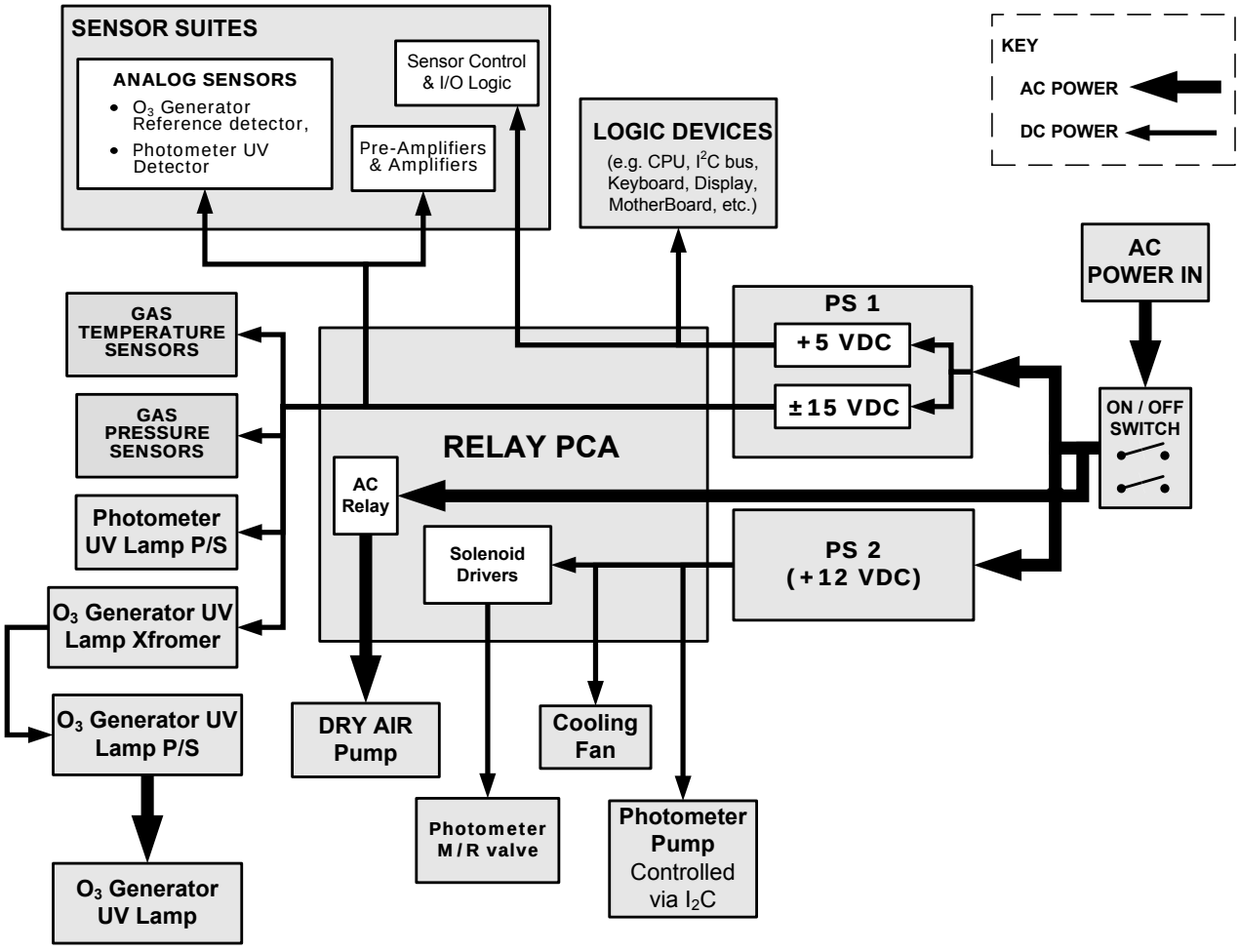


Figure 9-7: M703E Power Distribution Block diagram

9.2.6. AC POWER CONFIGURATION

The E-Series digital electronic systems will operate with any of the specified power regimes. As long as instrument is connected to 100-120 VAC or 220-240 VAC at either 50 or 60 Hz it will turn on and after about 30 seconds show a front panel display. Internally, the status LEDs located on the Relay PCA, Motherboard and CPU should turn on as soon as the power is supplied.

On the other hand, some of the calibrator's the dry air pump must be properly configured for the type of power being supplied to the instrument. Figure 2-3 shows the location of the Pump AC Configuration jumper.

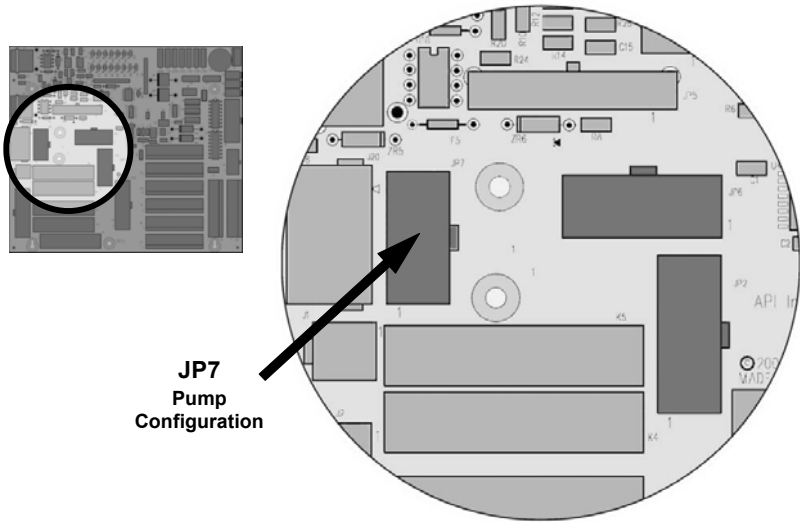


Figure 9-8: Location of the AC Configuration Jumper for the Dry Air Pump

9.2.6.1. AC configuration – Internal Pump (JP7)

AC power configuration for the internal dry air pump is set using Jumper set JP7.

Table 9-2: AC Power Configuration for Internal Pumps (JP7)

LINE POWER	LINE FREQUENCY	JUMPER COLOR	FUNCTION	JUMPER BETWEEN PINS
110VAC 115 VAC	60 HZ	WHITE	Connects pump pin 3 to 110 / 115 VAC power line	2 to 7
			Connects pump pin 3 to 110 / 115 VAC power line	3 to 8
			Connects pump pins 2 & 4 to Neutral	4 to 9
	50 HZ[1]	BLACK	Connects pump pin 3 to 110 / 115 VAC power line	2 to 7
			Connects pump pin 3 to 110 / 115 VAC power line	3 to 8
			Connects pump pins 2 & 4 to Neutral	4 to 9
220VAC 240 VAC	60 HZ	BROWN	Connects pump pins 3 and 4 together	1 to 6
			Connects pump pin 1 to 220 / 240VAC power line	3 to 8
	50 HZ[1]	BLUE	Connects pump pins 3 and 4 together	1 to 6
			Connects pump pin 1 to 220 / 240VAC power line	3 to 8

[1] A jumper between pins 5 and 10 may be present on the jumper plug assembly, but is only functional on the M300E and has no function on the Models M700E or M703E.

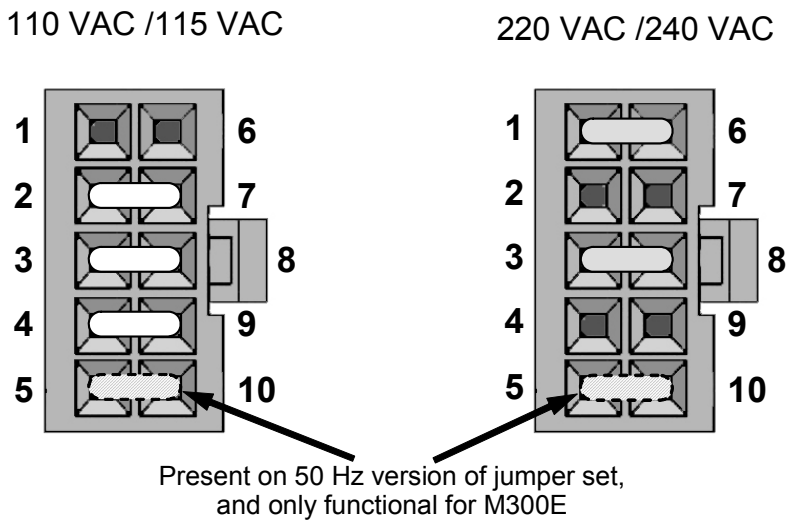


Figure 9-9: Pump AC Power Jumpers (JP7)

9.3. FRONT PANEL INTERFACE

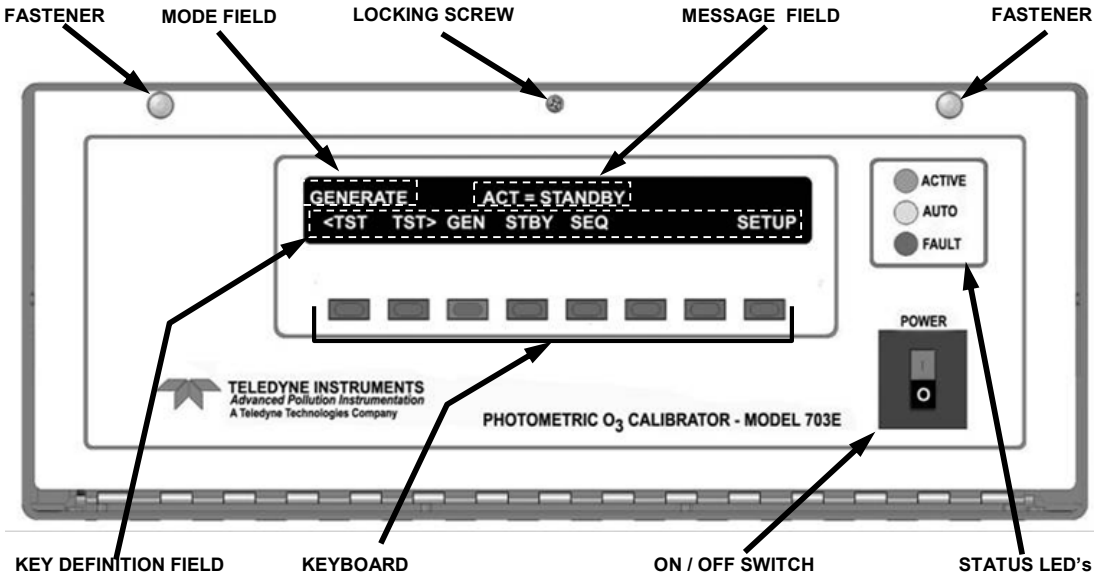


Figure 9-10: M703E Front Panel Layout

The most commonly used method for communicating with the M703E Photometric Calibrator is via the instrument's front panel, which includes a set of three status LEDs, a vacuum florescent display and a keyboard with 8 context sensitive keys.

9.3.1.1. Calibrator Status LEDs

Three LEDS are used to inform the user of the instruments basic operating status

Table 9-3: Front Panel Status LEDs

Name	Color	Behavior	Significance
Main Message Field	N/A	Displays Warning messages and Test Function values	At initial start up the various warning messages will appear here.
Mode Field	N/A	Displays "STANDBY"	Instrument is in **STANDBY** mode.
STATUS LEDs			
Active	Green	OFF	Unit is operating in **STANDBY** mode. This LED glows green when the instrument is actively producing calibration gas.
Auto	Yellow	OFF	This LED only glows when the calibrator is performing an automatic calibration sequence.
Fault	Red	BLINKING	The calibrator is warming up and therefore many of its subsystems are not yet operating within their optimum ranges. Various warning messages will appear.

9.3.1.2. Keyboard

A row of eight keys just below the vacuum florescent display (see Figure 9-10) is the main method by which the user interacts with the calibrator. As the software is operated, labels appear on the bottom row of the display directly above each active key, defining the function of that key as it is relevant for the operation being performed. Pressing a key causes the associated instruction to be performed by the calibrator.

Note that the keys do not auto-repeat. In circumstances where the same key must be activated for two consecutive operations, it must be released and re-pressed.

9.3.1.3. Display

The main display of the calibrator is a vacuum florescent display with two lines of 40 text characters each. Information is organized in the following manner (see Figure 9-10):

- MODE FIELD: Displays the name of the calibrator's current operating mode.
- MESSAGE FIELD: Displays a variety of informational messages such as warning messages, operation data and response messages during interactive tasks.
- KEY DEFINITION FIELD: Displays the definitions for the row of keys just below the display. These definitions dynamic, context sensitive and software driven.

9.3.1.4. Keyboard/Display Interface Electronics

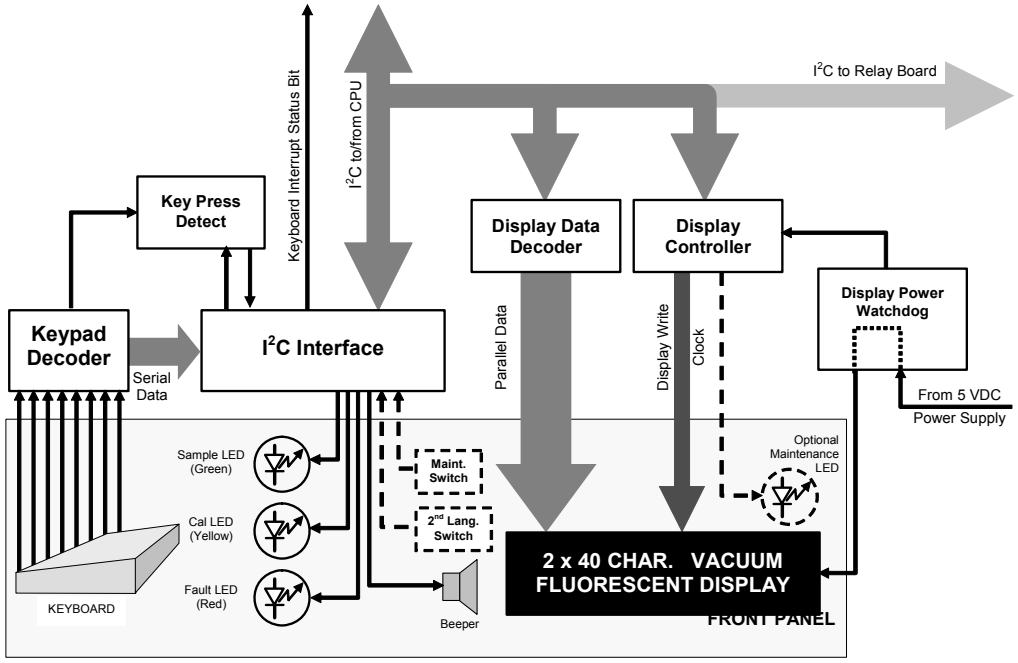


Figure 9-11: Keyboard and Display Interface Block Diagram

The keyboard/display interface electronics of the M703E Calibrator watches the status of the eight front panel keys, alerts the CPU when keys are depressed, translates data from parallel to serial and back and manages communications between the keyboard, the CPU and the front panel display. Except for the Keyboard interrupt status bit, all communication between the CPU and the keyboard/display is handled by way of the instrument's I^2C buss. The CPU controls the clock signal and determines when the various devices on the bus are allowed to talk or required to listen. Data packets are labeled with addresses that identify for which device the information is intended.

KEYPAD DECODER

Each key on the front panel communicates with a decoder IC via a separate analog line. When a key is depressed the decoder chip notices the change of state of the associated signal; latches and holds the state of all eight lines (in effect creating an 8-bit data word); alerts the key-depress-detect circuit (a flip-flop IC); translates the 8-bit word into serial data and; sends this to the I^2C interface chip.

KEY-PRESS DETECT CIRCUIT

This circuit flips the state of one of the inputs to the I^2C interface chip causing it to send an interrupt signal to the CPU

I^2C INTERFACE CHIP

- This IC performs several functions:
- Using a dedicated digital status bit, it sends an interrupt signal alerting the CPU that new data from the keyboard is ready to send.
- Upon acknowledgement by the CPU that it has received the new keyboard data, the I^2C interface chip resets the key-depress-detect flip-flop.
- In response to commands from the CPU, it turns the front panel status LEDs on and off and activates the beeper.
- Informs the CPU when the optional maintenance and second language switches have been opened or closed (see Chapter 5 for information on these options).

DISPLAY DATA DECODER

This decoder translates the serial data sent by the CPU (in TTY format) into a bitmapped image that is sent over a parallel data bus to the display.

DISPLAY CONTROLLER

This circuit manages the interactions between the display data decoder and the display itself. It generates a clock pulse that keeps the two devices synchronized. It can also, in response to commands from the CPU turn off and/or reset the display.

DISPLAY POWER WATCHDOG

The M703E calibrator's display can begin to show garbled information or lock-up if the DC voltage supplied to it falls too low, even momentarily. To alleviate this, a brownout watchdog circuit monitors the level of the power supply and in the event that the voltage level falls below a certain level resets the display by turning it off, then back on.

9.4. SOFTWARE OPERATION

The M703E calibrator's core module is a high performance, 386-based microcomputer running a version of DOS. On top of the DOS shell, special software developed by Teledyne Instruments interprets user commands from various interfaces, performs procedures and tasks, stores data in the CPU's memory devices and calculates the concentrations in the sample gas. Figure 9-11 shows a block diagram of this software functionality.

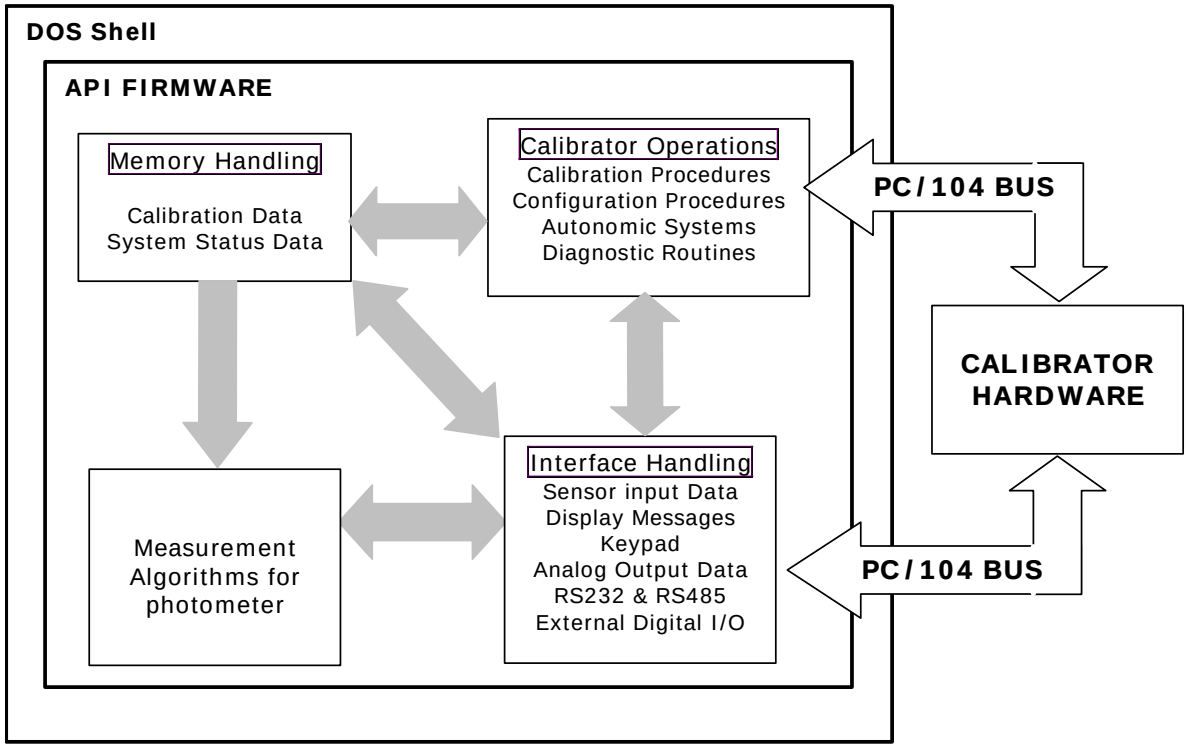


Figure 9-12: Schematic of Basic Software Operation

9.5. O_3 GENERATOR OPERATION

9.5.1. PRINCIPLE OF PHOTOLYTIC O_3 GENERATION

Ozone is a naturally occurring substance that is sometimes called "activated oxygen". It contains three atoms of oxygen (O3) instead of the usual two found in normal oxygen (O2) that is essential for life. Because of its relatively short half-life, ozone cannot be bottled and stored for later use and there fore must always be generated on-site by an ozone generator. The two main principles of ozone generation are UV-light and corona discharge. While the corona-discharge method is most common because of its ability to generate very high concentrations (up to 50%), it is inappropriate for calibration needs since the level of fine control over the O_3 concentration is poor. Also, the corona discharge method produces a small amount of NO_2 as a byproduct, which also may be undesirable in a calibration application

The UV-light method is most feasible in calibration application where production of low, accurate concentrations of ozone desired. This method mimics the radiation method that occurs naturally from the sun in the upper atmosphere producing the ozone layer. An ultra-violet lamp inside the generator emits a precise wavelength of UV Light (185 nm). Ambient air] is passed over an ultraviolet lamp, which splits some of the molecular oxygen (O_2) in the gas into individual oxygen atoms which attach to other existing oxygen molecules (O_2), forming ozone (O_3).

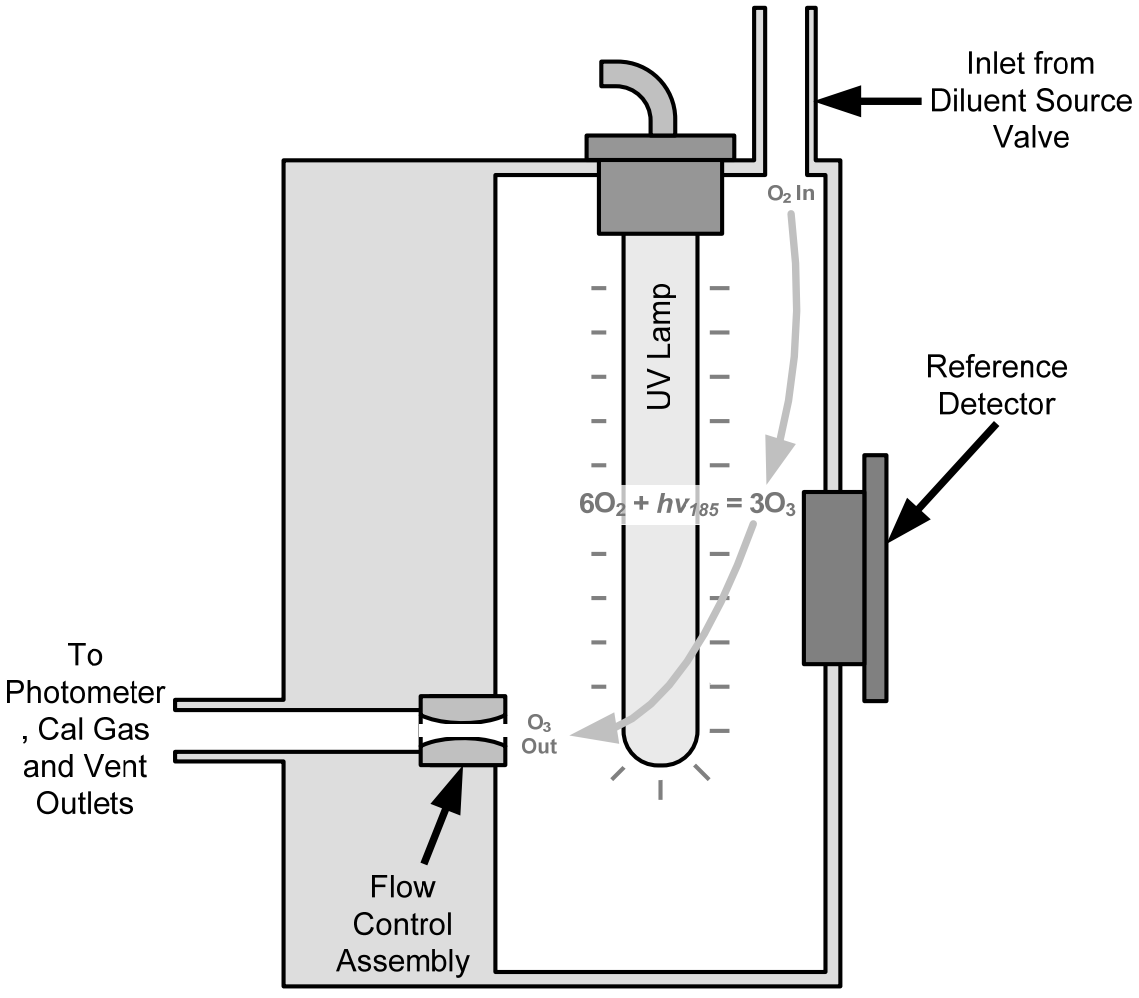


Figure 9-13: O_3 Generator Internal Pneumatics

9.5.2. GENERATOR PNEUMATIC OPERATION

The rate of flow through the O_3 generator is controlled by a flow control assembly located on the Regulator Sub-Assembly in the front of the M703E.

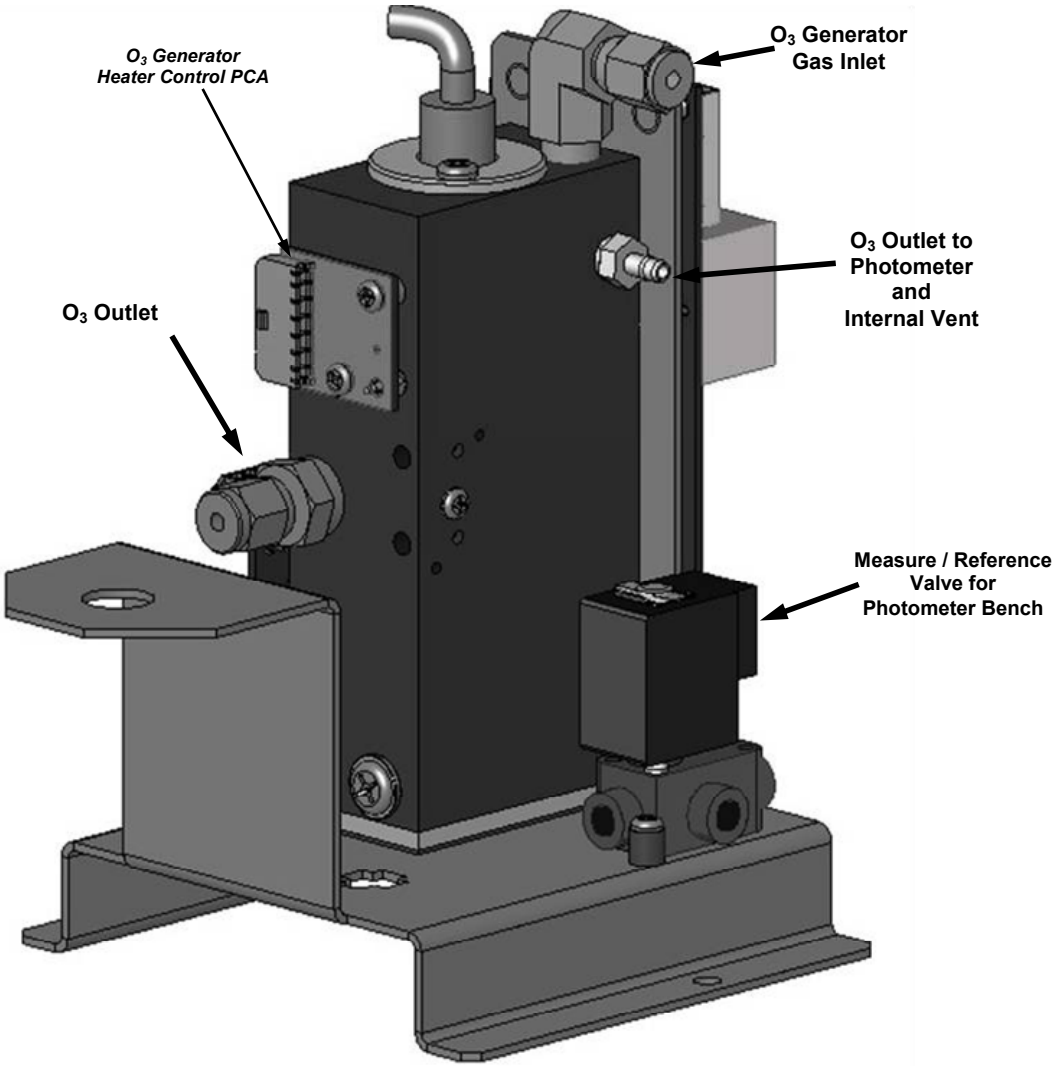

O_3 Generator Heater Control PCA
O_3 Generator Gas Inlet
O_3 Outlet to Photometer and Internal Vent
O_3 Outlet
Measure / Reference Valve for Photometer Bench

Figure 9-14: O_3 Generator Valve and Gas Fixture Locations

9.5.3. O_3 GENERATOR ELECTRONIC OPERATION

Electronically the O_3 generator and its subcomponents act as peripheral devices operated by the CPU via the motherboard. Sensor signals, such as the UV lamp thermistor are routed to the motherboard, where they are digitized. Digital data is sent by the motherboard to the calibrator's CPU and where required stored in either flash memory or on the CPU's disk-on-chip. Commands from the CPU are sent to the motherboard and forwarded to the various devices via the calibrator's I^2C bus.

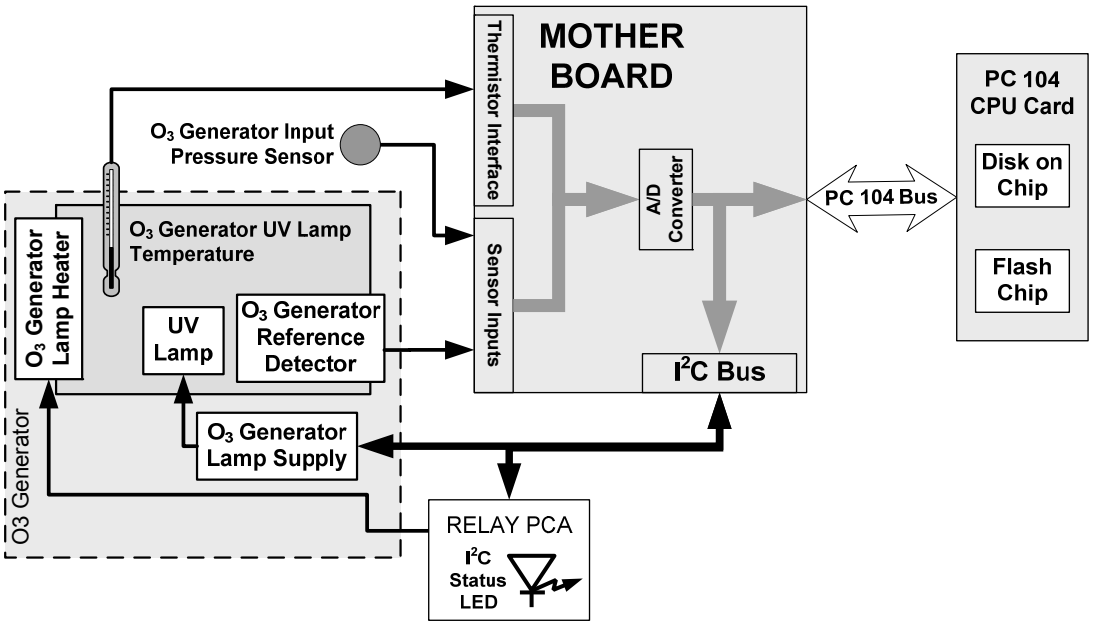


Figure 9-15: O_3 Generator Electronic Block Diagram

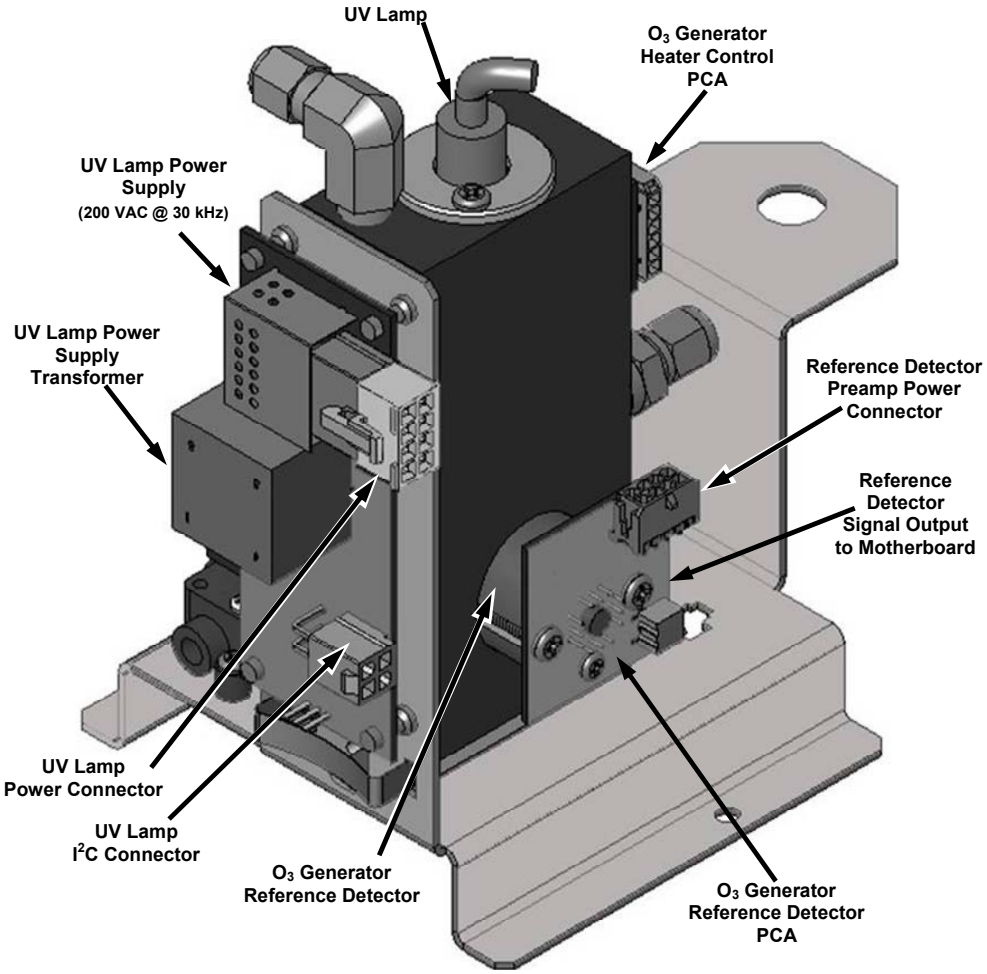

UV Lamp
O₃ Generator Heater Control PCA
UV Lamp Power Supply (200 VAC @ 30 kHz)
UV Lamp Power Supply Transformer
Reference Detector Preamp Power Connector
Reference Detector Signal Output to Motherboard
UV Lamp Power Connector
UV Lamp I²C Connector
O₃ Generator Reference Detector
O₃ Generator Reference Detector PCA

Figure 9-16: O_3 Generator Electronic Components Location

9.5.3.1. O_3 Generator Temperature Control

In order to operate at peak efficiency the UV lamp of the M703E's O_3 generator is maintained at a constant 48ºC. if the lamp temperature falls below 43ºC or rises above 53ºC a warning is issued by the calibrators CPU.

This temperature is controlled as described in the section on the relay PCA (see Section 9.2.3.2). The location of the thermistor and heater associated with the O_3 generator is shown below:

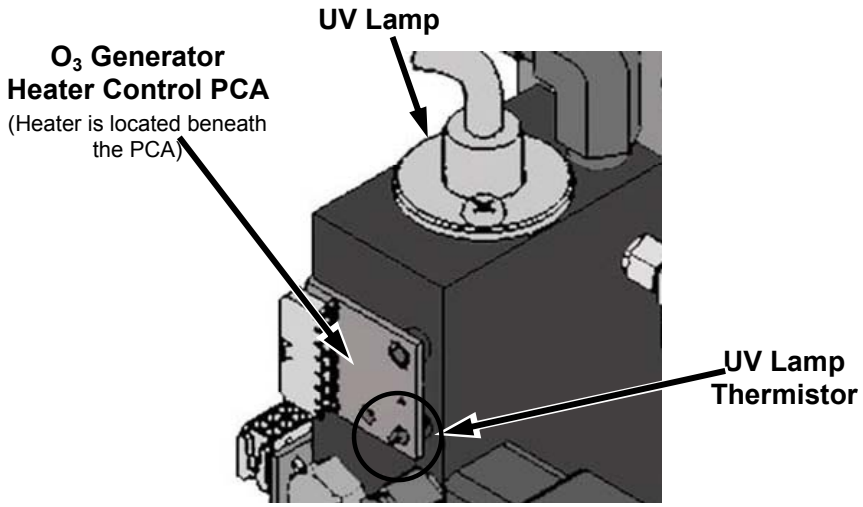


Figure 9-17: O_3 Generator Temperature Thermistor and DC Heater Locations

9.6. PHOTOMETER OPERATION

The Model M703E calibrator's optional photometer determines the concentration of Ozone (O_3) in a sample gas drawn through it. Sample and calibration gasses must be supplied at ambient atmospheric pressure in order to establish a stable gas flow through the absorption tube where the gas' ability to absorb ultraviolet (UV) radiation of a certain wavelength (in this case 254 nm) is measured.

Gas bearing O_3 and zero air are alternately routed through the photometer's absorption tube. Measurements of the UV light passing through the sample gas with and without O_3 present are made and recorded.

Calibration of the photometer is performed in software and does not require physical adjustments. Two internal variables, a slope and offset are used to adjust the calibration of the photometer.

The CPU uses these calibration values, the UV absorption measurements made on the sample gas in the absorption tube along with data regarding the current temperature and pressure of the gas to calculate a final O_3 concentration.

9.6.1. MEASUREMENT METHOD

9.6.1.1. Calculating O_3 Concentration

The basic principle by which photometer works is called Beer's Law (also referred to as the Beer-Lambert equation). It defines the how light of a specific wavelength is absorbed by a particular gas molecule over a certain distance at a given temperature and pressure. The mathematical relationship between these three parameters for gasses at Standard Temperature and Pressure (STP) is:

Equation 9-5

$$I = I_0 e^{-\alpha LC} \quad at\ STP$$

Where:

I_o is the intensity of the light if there was no absorption.

I is the intensity with absorption.

L is the absorption path, or the distance the light travels as it is being absorbed.

C is the concentration of the absorbing gas. In the case of the Model 703E, Ozone (O_3).

A is the absorption coefficient that tells how well O_3 absorbs light at the specific wavelength of interest.

To solve this equation for **C**, the concentration of the absorbing Gas (in this case O_3), the application of a little algebra is required to rearrange the equation as follows:

Equation 9-6

$$C = ln\ \frac{I_o}{I} \times \frac{1}{\alpha L} \quad at\ STP$$

Unfortunately, both ambient temperature and pressure influence the density of the sample gas and therefore the number of ozone molecules present in the absorption tube thus changing the amount of light absorbed.

In order to account for this effect the following addition is made to the equation:

Equation 9-7

$$C = ln\ \frac{I_o}{I} \times \frac{1}{\alpha\ L} \times \frac{T}{273^o K} \times \frac{29.92 inHg}{P}$$

Where:

T = sample ambient temperature in degrees Kelvin

P = ambient pressure in inches of mercury

Finally, to convert the result into Parts per Billion (PPB), the following change is made:

Equation 9-8

$$C = ln\ \frac{I_o}{I} \times \frac{10^{\ 9}}{\alpha\ L} \times \frac{T}{273^o K} \times \frac{29.92 inHg}{P}$$

In a nutshell the M703E photometer:

- Measures each of the above variables: ambient temperature; ambient gas pressure; the intensity of the UV light beam with and without O_3 present;
- Inserts know values for the length of the absorption path and the absorption coefficient, and:
- Calculates the concentration of O_3 present in the sample gas.

9.6.1.2. The Measurement / Reference Cycle

In order to solve the Beer-Lambert equation it is necessary to know the intensity of the light passing through the absorption path both when O_3 is present and when it is not. A valve called the measure/reference valve, physically located on front-left corner of the O_3 generator assembly (see Figures 3-4 and 9-14) alternates the gas stream flowing to the photometer between zero air (diluent gas) and the O_3 output from the O_3 generator. This cycle takes about 6 seconds.

Table 9-4: M703E Photometer Measurement / Reference Cycle

TIME INDEX	STATUS
0 sec.	Measure/Reference Valve Opens to the Measure Path.
0 – 2 sec.	Wait Period. Ensures that the Absorption tube has been adequately flushed of any previously present gasses.
2 – 3 Seconds	Analyzer measures the average UV light intensity of O_3 bearing Sample Gas (I) during this period.
3 sec.	Measure/Reference Valve Opens to the Reference Path.
3 – 5 sec.	Wait Period. Ensures that the Absorption tube has been adequately flushed of O_3 bearing gas.
5 – 6 Seconds	Analyzer measures the average UV light intensity of Non-O_3 bearing Sample Gas (I_0) during this period.
CYCLE REPEAT EVERY 6 SECONDS	

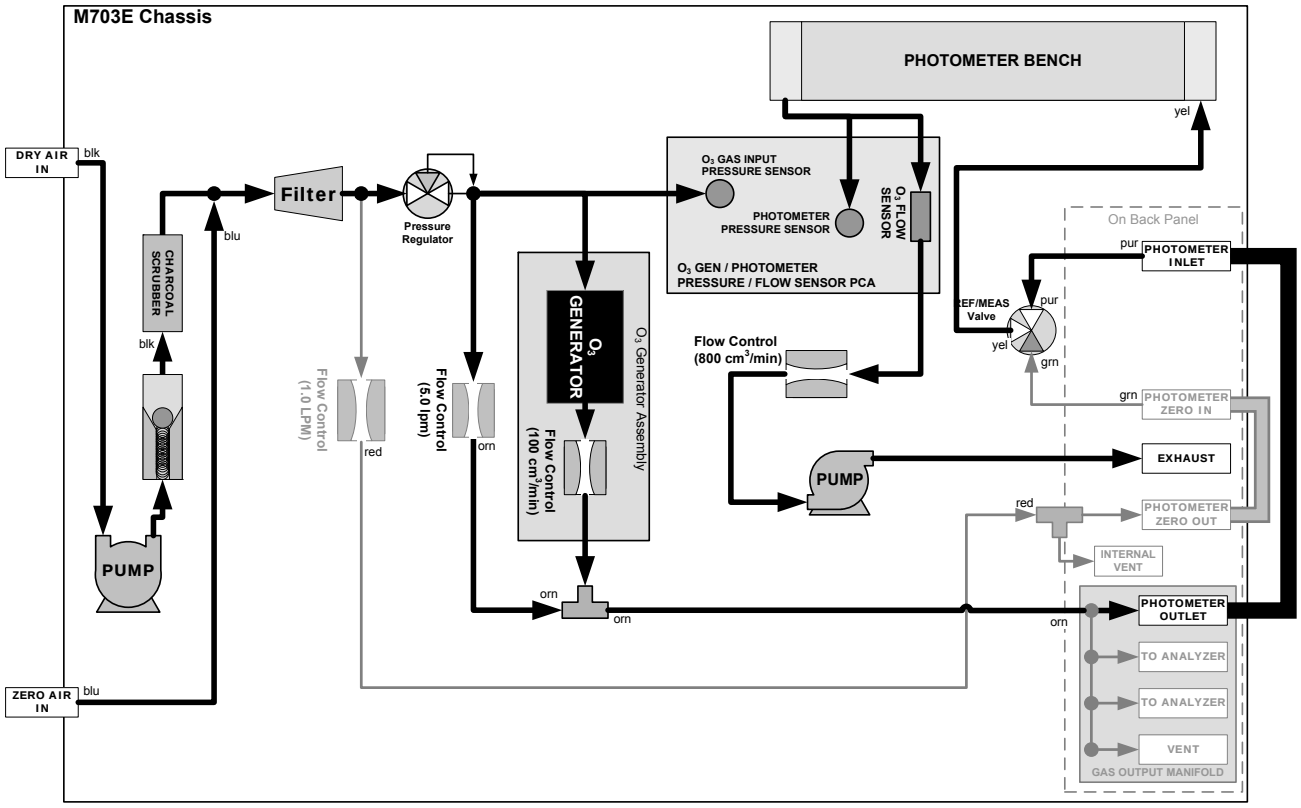


Figure 9-18: O_3 Photometer Gas Flow – Measure Cycle

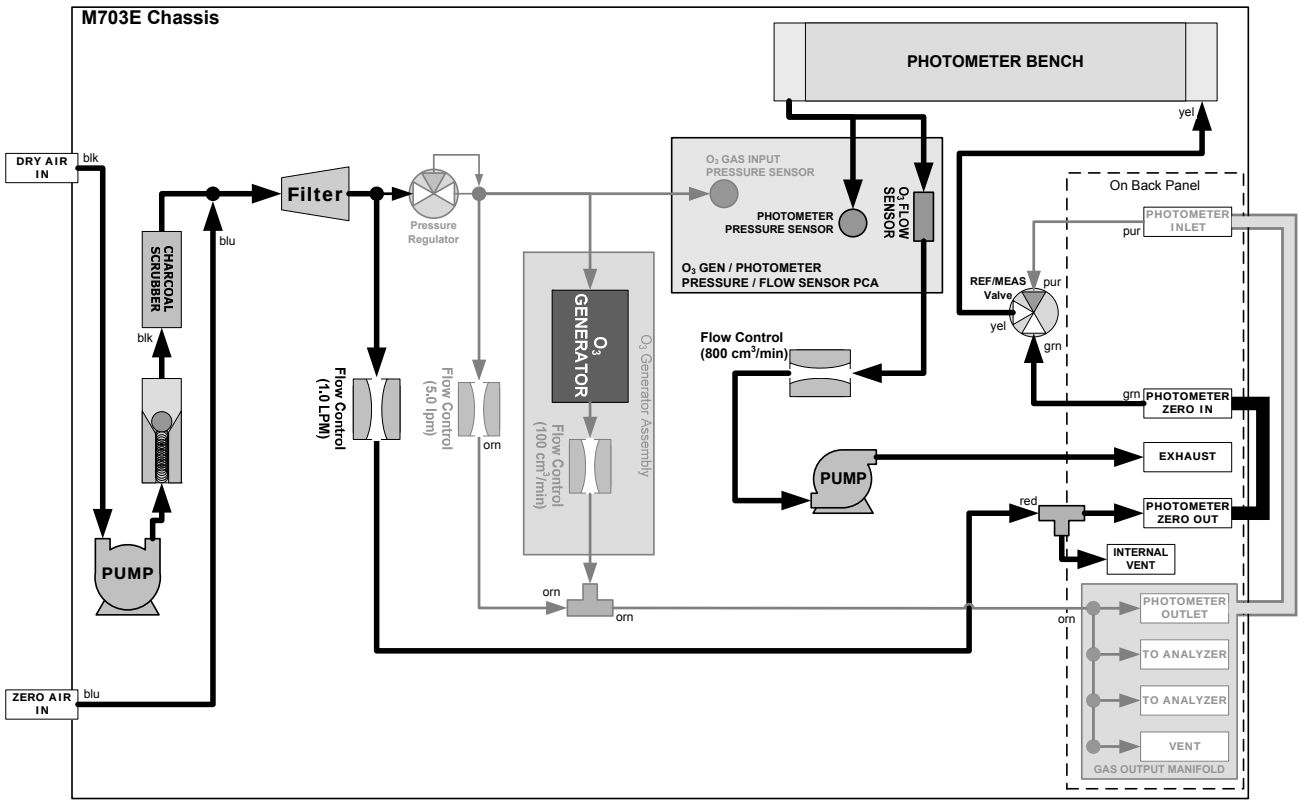


Figure 9-19: O_3 Photometer Gas Flow – Reference Cycle

9.6.1.3. The Absorption Path

In the most basic terms, the M703E photometer uses a high energy, mercury vapor lamp to generate a beam of UV light. This beam passes through a window of material specifically chosen to be both non-reactive to O_3 and transparent to UV radiation at 254nm and into an absorption tube filled with sample gas.

Because ozone is a very efficient absorber of UV radiation the absorption path length required to create a measurable decrease in UV intensity is short enough (approximately 42 cm) that the light beam is only required to make one pass through the Absorption Tube. Therefore, no complex mirror system is needed to lengthen the effective path by bouncing the beam back and forth.

Finally, the UV passes through a similar window at the other end of the absorption tube and is detected by a specially designed vacuum diode that only detects radiation at or very near a wavelength of 254nm. The specificity of the detector is high enough that no extra optical filtering of the UV light is needed.

The detector reacts to the UV light and outputs a current signal that varies in direct relationship with the intensity of the light shining on it. This current signal is amplified and converted to a 0 to 5 VDC voltage analog signal voltage sent to the instrument's motherboard where it is digitized. The CPU to be uses this digital data in computing the concentration of O_3 in the absorption tube.

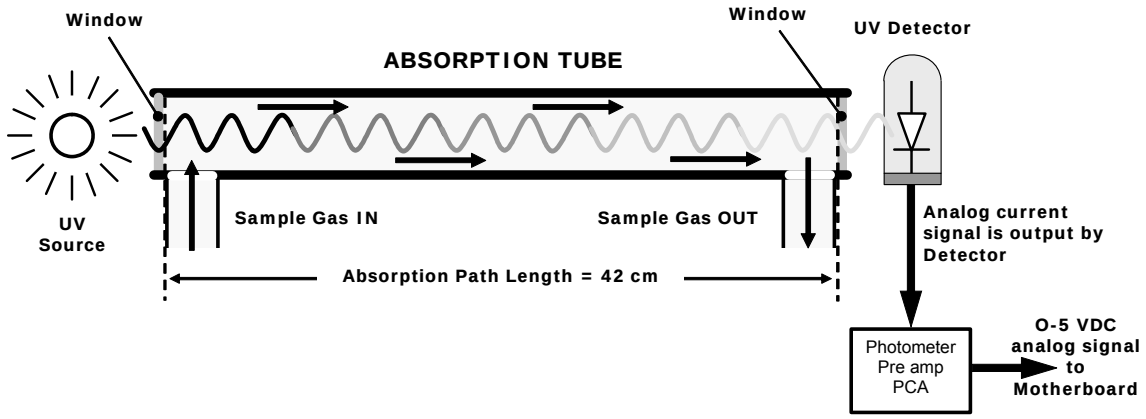


Figure 9-20: O_3 Photometer Absorption Path

9.6.1.4. Interferent Rejection

It should be noted that the UV absorption method for detecting ozone is subject to interference from a number of sources. The has M703E's photometer been successfully tested for its ability to reject interference from sulfur dioxide, nitrogen dioxide, nitric oxide, water, and meta-xylene.

While the photometer rejects interference from the aromatic hydrocarbon meta-xylene, it should be noted that there are a very large number of other volatile aromatic hydrocarbons that could potentially interfere with ozone detection. If the M703E calibrator is installed in an environment where high aromatic hydrocarbon concentrations are suspected, specific tests should be conducted to reveal the amount of interference these compounds may be causing.

9.6.2. PHOTOMETER LAYOUT

The Photometer is where the absorption of UV light by ozone is measured and converted into a voltage. It consists of several sub-assemblies:

- A mercury-vapor UV lamp. This lamp is coated in a material that optically screens the UV radiation output to remove the O_3 producing 185nm radiation. Only light at 254nm is emitted.
- An AC power supply that supplies the current for starting and maintaining the plasma arc of the mercury vapor lamp.
- A thermistor and DC heater attached to the UV Lamp to maintain the Lamp at an optimum operating temperature.
- 42 cm long quartz absorption tube.
- A thermistor attached to the quartz tube for measuring sample gas temperature.
- Gas inlet and outlet mounting blocks that rout sample gas into and out of the photometer.
- The vacuum diode, UV detector that converts UV light to a DC current.
- A preamplifier assembly, which convert the Detector's current output into a DC Voltage then amplifies it to a level readable by the A to D converter circuitry of the instrument's motherboard
-

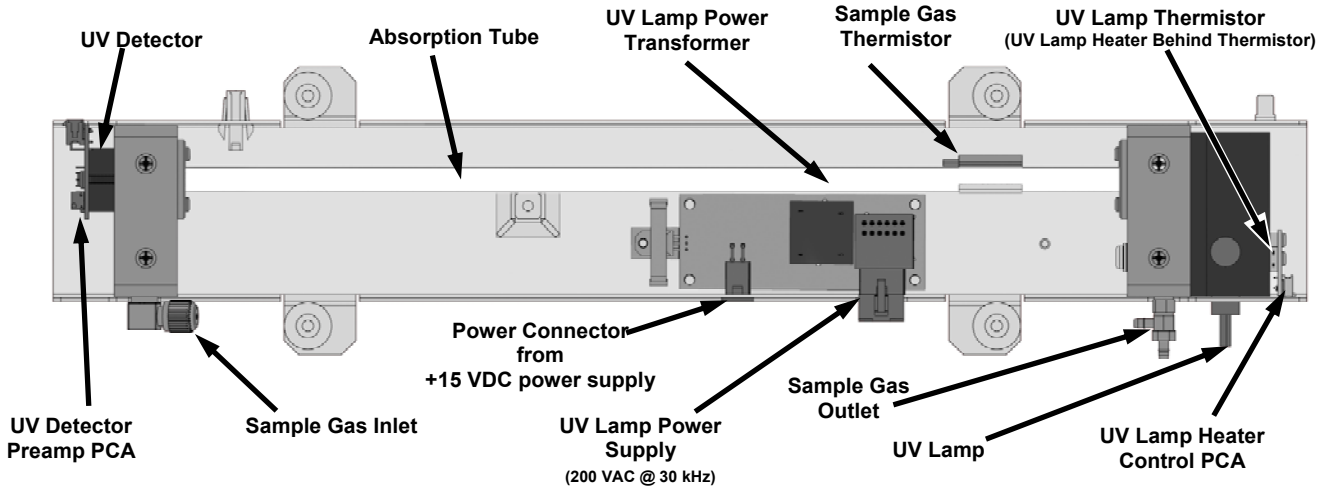


Figure 9-21: O_3 Photometer Layout – Top Cover Removed

9.6.3. PHOTOMETER PNEUMATIC OPERATION

The flow of gas through the photometer is created by a small internal pump that pulls air though the instrument. There are several advantages to this "pull through" configuration. Placing the pump down stream from the absorption tube avoids problems caused by the pumping process heating and compressing the sample.

In order to measure accurately the presences of low concentrations of O_3 in the sample air it is necessary to establish and maintain a relatively constant and stable volumetric flow of sample gas through the photometer. The simplest way to accomplish this is by placing a flow control assembly containing a critical flow orifice directly upstream of the pump but down stream from the absorption tube.

The critical flow orifice installed in the pump supply line is tuned to create a gas flow of 800 cm^3/min. A pressure sensor and a flow sensor, located on the O_3 generator / photometer pressure flow sensor PCA, monitor the pressure and flow rate of the gas passing through the photometers absorption tube.

See Figures 9-18 and 9-19 for depictions of the gas flow related to the photometer.

9.6.4. PHOTOMETER ELECTRONIC OPERATION

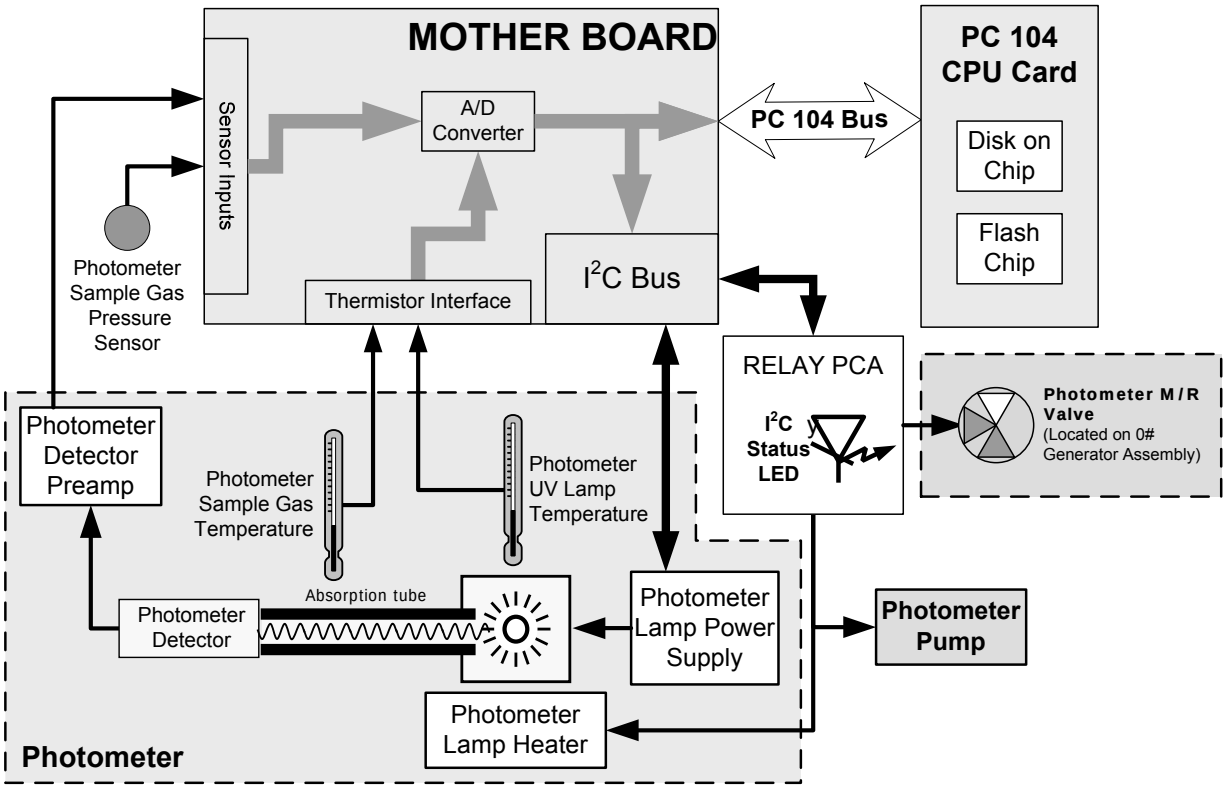


Figure 9-22: O_3 Photometer Electronic Block Diagram

Like the O_3 generator, the O_3 photometer and its subcomponents act as peripheral devices operated by the CPU via the motherboard. Communications to and from the CPU are handled by the motherboard.

Outgoing commands for the various devices such as the photometer pump, the UV lamp power supply the U\V Lamp heater are issued via the I^2C bus to circuitry on the relay PCA which turns them ON/OFF. The CPU also issues commands over the I^2C bus that cause the relay PCA to cycle the measure/reference valve back and forth.

Incoming date the UV light detector is amplified locally then converted to digital information by the motherboard. Output from the photometers temperature sensors is also amplified and converted to digital data by the motherboard. The O_3 concentration of the sample gas is computed by the CPU using this data (along with gas pressure and flow data received from the M703E's pressure sensors.

9.6.4.1. O_3 Photometer Temperature Control

In order to operate at peak efficiency the UV lamp of the M703E's O_3 photometer is maintained at a constant 58ºC. This is intentionally set at a temperature higher than the ambient temperature of the M703E's operating environment to make sure that local changes in temperature do not affect the UV Lamp. If the lamp temperature falls below 56ºC or rises above 61ºC a warning is issued by the calibrators CPU.

This temperature is controlled as described in the section on the relay PCA (Section 9.3.3.2).

The following TEST functions report these temperatures and are viewable from the instrument's front panel:

- **PHOTO LAMP TEMP** - The temperature of the UV Lamp reported in ºC.
- **PHOTO STEMP** - The temperature of the Sample gas in the absorption tube reported in ºC.

9.6.4.2. Pneumatic Sensors for the O_3 Photometer

The several sensors located on the pneumatic sensor just to the left rear of the O_3 generator assembly measure the absolute pressure and the flow rate of gas inside the photometer's absorption tube. This information is used by the CPU to calculate the O_3 concentration of the sample gas (See Equation 9-7). Both of these measurements are made downstream from the absorption tube but upstream of the pump. A critical flow orifice located between the flow sensor and the pump maintains the gas flow through the photometer at 800 cm^3/min.

The following TEST functions are viewable from the instrument's front panel:

- **PHOTO FLOW** - The flow rate of gas through the photometer measured in LPM.
- **PHOTO SPRESS** – the pressure of the gas inside the absorption tube. This pressure is reported in inches of mercury-absolute (**in-Hg-A**), i.e. referenced to a vacuum (zero absolute pressure). This is not the same as **PSIG.**

USER NOTES:

USER NOTES:

10. MAINTENANCE SCHEDULE & PROCEDURES

Predictive diagnostic functions including failure warnings and alarms built into the calibrator's firmware allow the user to determine when repairs are necessary without performing painstaking preventative maintenance procedures.

For the most part, the M703E calibrator is maintenance free, there are, however, a minimal number of simple procedures that when performed regularly will ensure that the M703E photometer continues to operate accurately and reliably over its the lifetime.

Repairs and troubleshooting are covered in Section 11 of this manual.

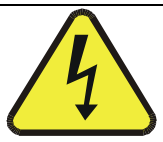
10.1. MAINTENANCE SCHEDULE

Table 10-1 below shows the recommended maintenance schedule for the M703E. Please note that in certain environments (i.e. dusty, very high ambient pollutant levels) some maintenance procedures may need to be performed more often than shown.

NOTE

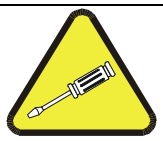
A Span and Zero Calibration Check (see CAL CHECK REQ'D Column of Table 10-1) must be performed following certain of the maintenance procedure listed below.

See Section 8.1 for instructions on performing a calibration check.



CAUTION

RISK OF ELECTRICAL SHOCK. DISCONNECT POWER BEFORE PERFORMING ANY OF THE FOLLOWING OPERATIONS THAT REQUIRE ENTRY INTO THE INTERIOR OF THE ANALYZER.



NOTE

THE OPERATIONS OUTLINED IN THIS CHAPTER ARE TO BE PERFORMED BY QUALIFIED MAINTENANCE PERSONNEL ONLY.

USER NOTES:

Table 10-1: M703E Maintenance Schedule

Item	Action	Freq	Cal Check Req'd.	Manual Section	Date Performed									
Verify Test Functions	Record and analyze	Weekly or after any Maintenance or Repair	No											
Photometer Pump Diaphragm	**No Replacement Required. Under Normal Circumstances the Pumps Will Last the Lifetime of the Instrument.**													
Dry Air Pump Diaphragm	Replace	Annually	Yes	10.4										
Absorption Tube	Inspect - - - Clean	As Needed	Yes after cleaning	10.2	**Cleaning of the Photometer Absorption Tube Should Not Be Required as long as ONLY CLEAN, DRY, PARTICULATE FREE Zero Air (Diluent Gas) is used with the M703E Calibrator**									
Perform Leak Check	Verify Leak Tight	Annually or after any Maintenance or Repair	N0											
Pneumatic lines	Examine and clean	As needed	Yes if cleaned	- - -										

USER NOTES:

10.2. PERFORMING LEAK CHECKS

Leaks are the most common cause of analyzer malfunction; Section **Error! Reference source not found.** presents a simple leak check procedure. Section 10.2.1 describes a more thorough procedure.

10.2.1. PRESSURE LEAK CHECK

- BEGINNING OF INSERTION: Replace original section below with this section, per Mike Troy:

Obtain a leak checker similar to the Teledyne Instruments' part number 01960, which contains a small pump, shut-off valve and pressure gauge. Alternatively, a tank of pressurized gas, with the two-stage regulator adjusted to ≤ 15 psi, a shutoff valve and pressure gauge may be used.

CAUTION

Once the fittings have been wetted with soap solution, do not apply a vacuum as this will cause soap solution to be drawn into the instrument, contaminating it.

DO NOT EXCEED 15 PSI PRESSURE.

1. Turn OFF power to the calibrator.
2. Remove the instrument cover
3. Install a leak checker or tank of gas as described above on the "dry air in" port at the rear panel.
4. Install caps on the following fittings on the rear panel.
   - Exhaust
   - Vent
   - Internal Vent
   - Zero
   - Air Inlet
   - Both CALGAS OUT fittings

NOTE

The M703E calibrator cannot be leak checked with the pump in line due to internal leakage that normally occurs in the pump.

5. Locate the dry air pump.
6. Disconnect the two fittings on the dry air pump and install a union fitting in place of the pump.
7. Locate the photometer pump.
8. Disconnect the two fittings on the photometer pump and install a union fitting in place of the pump.
9. Pressurize the calibrator with the leak checker, allowing enough time to pressurize the instrument fully.
10. Check each fitting with soap bubble solution, looking for bubbles.

- Once the fittings have been wetted with soap solution.
- Do not re-apply vacuum as it will draw soap solution into the instrument and contaminate it.
- Do not exceed 15 psi pressure.

11. Once the leak has been located and repaired, the leak-down rate should be < 1 in-Hg (0.4 psi) in 5 minutes after the pressure is shut off.

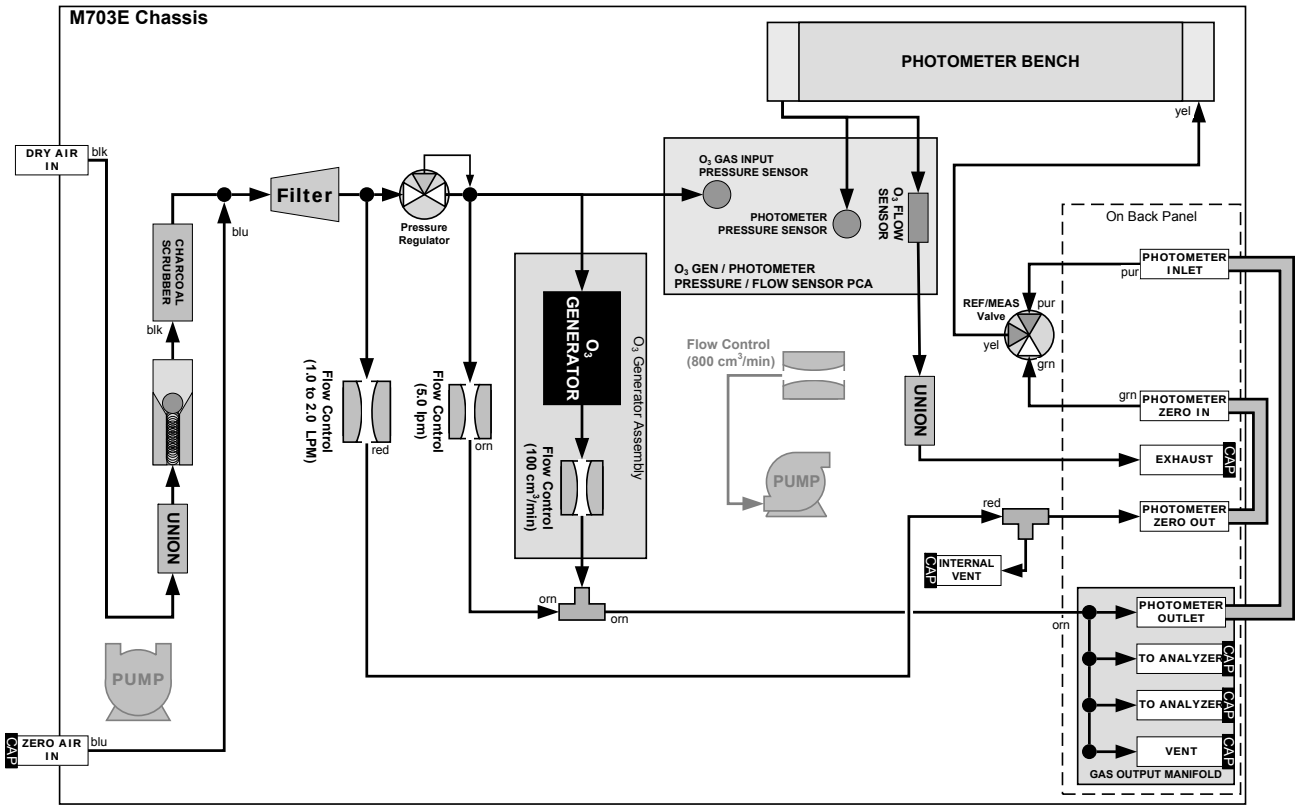


Figure 10-1: Pneumatic setup for performing Pressure Leak Checks

-END OF INSERTION

If you cannot locate the leak by the above procedure, obtain a leak checker similar to the Teledyne Instruments' part number 01960, which contains a small pump, shut-off valve and pressure gauge. Alternatively, a tank of pressurized gas, with the two-stage regulator adjusted to ≤ 15 psi, a shutoff valve and pressure gauge may be used.

CAUTION

Once the fittings have been wetted with soap solution, do not apply / re-apply vacuum as this will cause soap solution to be drawn into the instrument, contaminating it.

DO NOT EXCEED 15 PSI PRESSURE.

1. Turn OFF power to the instrument.
2. Install a leak checker or tank of gas as described above on the sample inlet at the rear panel.
3. Install caps on the following fittings on the rear panel.
   - Exhaust
   - Vent
   - Internal Vent
   - Zero
   - Air Inlet
   - Both CALGAS OUT fittings

NOTE

The M703E calibrator cannot be leak checked with the pump in line due to internal leakage that normally occurs in the pump.

1. Remove the instrument cover
2. Locate the photometer pump.
3. Disconnect the two fittings on the photometer pump and install a union fitting in place of the pump.
4. Locate the dry air pump.
5. Disconnect the two fittings on the dry air pump and install a union fitting in place of the pump.
6. Locate the photometer pump.
7. Disconnect the two fittings on the photometer pump and install a union fitting in place of the pump.
8. Pressurize the instrument with the leak checker, allowing enough time to pressurize the instrument fully.
9. Check each fitting with soap bubble solution, looking for bubbles.
   - Once the fittings have been wetted with soap solution.
   - Do not re-apply vacuum as it will draw soap solution into the instrument and contaminate it.
   - Do not exceed 15 psi pressure.
10. Once the leak has been located and repaired, the leak-down rate should be < 1 in-Hg (0.4 psi) in 5 minutes after the pressure is shut off.

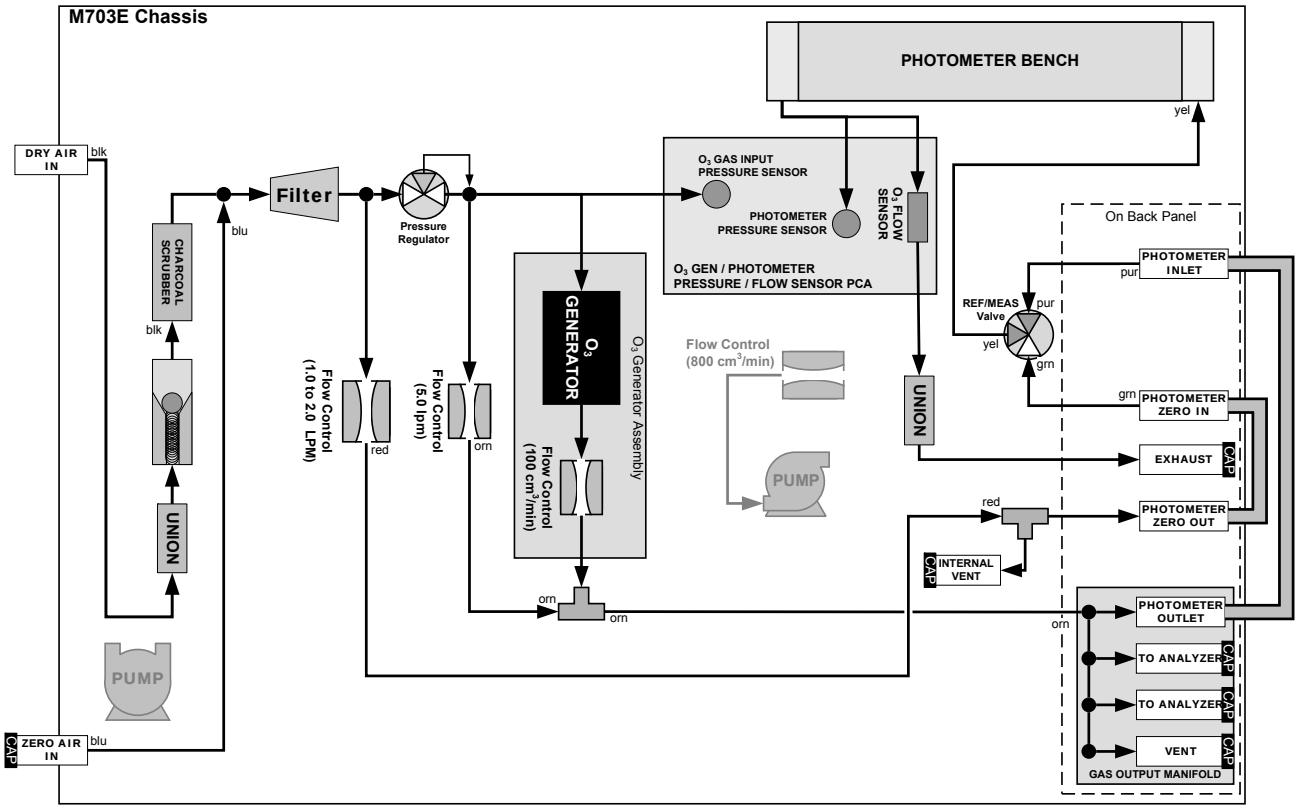


Figure 10-2: Pneumatic setup for performing Pressure Leak Checks

10.3. CLEANING OR REPLACING THE ABSORPTION TUBE

NOTE:

Although this procedure should never be needed as long as the user is careful only to supply the photometer with clean, dry and particulate free zero air, it is included here for those rare occasions when cleaning or replacing the absorption tube may be required.

1. Remove the center cover from the optical bench.
2. Unclip the sample thermistor from the tube.
3. Loosen the two screws on the round tube retainers at either end of the tube.
4. Using both hands, carefully rotate the tube to free it.
5. Slide the tube towards the lamp housing.
   - The front of the tube can now be slid past the detector block and out of the instrument.

CAUTION

**DO NOT CAUSE THE TUBE TO BIND AGAINST THE METAL HOUSINGS.
THE TUBE MAY BREAK AND CAUSE SERIOUS INJURY.**

6. Clean the tube with Distilled or de-ionized water by running a swab from end-to-end.
7. Air-dry the tube.
8. Check the cleaning job by looking down the bore of the tube.
   - It should be free from dirt and lint.
9. Inspect the o-rings that seal the ends of the optical tube (these o-rings may stay seated in the manifolds when the tube is removed.)
   - If there is any noticeable damage to these o-rings, they should be replaced.
10. Re-assemble the tube into the lamp housing and perform an **AUTO LEAK CHECK** on the instrument.

NOTE:

It is important for proper optical alignment that the tube be pushed all the way towards the front of the optical bench when it is re-assembled.

This will ensure that the tube is assembled with the forward end against the stop inside the detector manifold.

10.4. REBUILDING THE DRY AIR PUMP

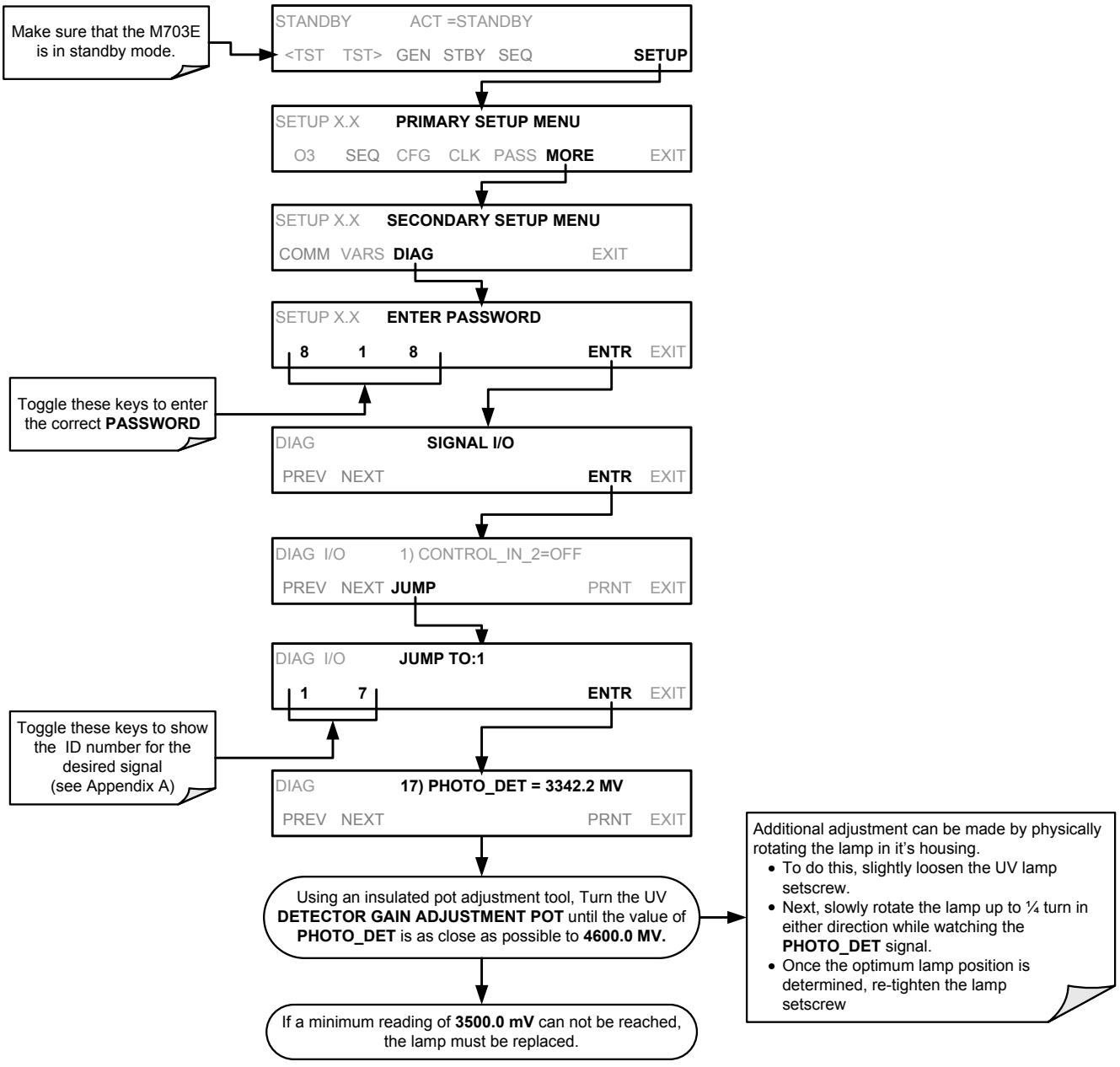
The diaphragm in the sample pump will periodically wear out and require replacement. A sample rebuild kit is available. See Appendix B of this manual for the part number of the pump rebuild kit. Instructions and diagrams are included with the kit.

Always perform a Flow and Leak Check after rebuilding the Sample Pump.

10.5. PHOTOMETER UV SOURCE LAMP ADJUSTMENT

This procedure details the steps for adjustment of the UV source lamp in the optical bench assembly. This procedure should be done whenever the **PHOTO REFERENCE** test function value drops below 3000 mV.

1. Make sure the analyzer is warmed-up and has been running for at least 15 minutes before proceeding.
2. Remove the cover from the analyzer.
3. Locate the optional Photometer (see Figure 3-3)
4. Locate the **UV DETECTOR GAIN ADJUST POT** on the photometer assembly (see Figure 10-3).
5. Perform the following procedure:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
DIAG I/O 1) CONTROL_IN_2=OFF
PREV NEXT JUMP PRNT EXIT
DIAG I/O JUMP TO:1
1 7 ENTR EXIT
Toggle these keys to show the ID number for the desired signal (see Appendix A)
DIAG 17) PHOTO_DET = 3342.2 MV
PREV NEXT PRNT EXIT
Using an insulated pot adjustment tool, Turn the UV DETECTOR GAIN ADJUSTMENT POT until the value of PHOTO_DET is as close as possible to 4600.0 MV.
If a minimum reading of 3500.0 mV can not be reached, the lamp must be replaced.
Additional adjustment can be made by physically rotating the lamp in it's housing.
• To do this, slightly loosen the UV lamp setscrew.
• Next, slowly rotate the lamp up to ¼ turn in either direction while watching the PHOTO_DET signal.
• Once the optimum lamp position is determined, re-tighten the lamp setscrew

6. Replace the cover on the analyzer.

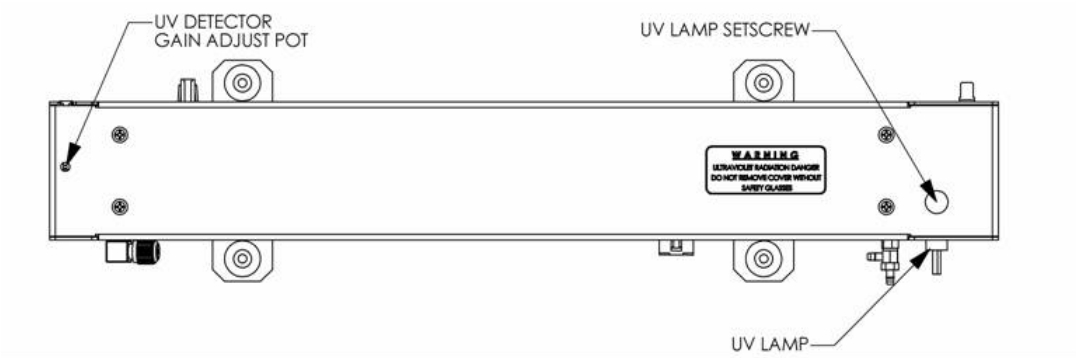


Figure 10-3: Photometer – Location of UV Detector Gain Adjustment & UV Lamp Set Screw

10.6. PHOTOMETER UV SOURCE LAMP REPLACEMENT

This procedure details the steps for replacement of the UV source lamp in the optical bench assembly. This procedure should be done whenever the lamp can no longer be adjusted as described in Section 10.2.3.

1. Turn the analyzer off.
2. Remove the cover from the analyzer.
3. Locate the Optical Bench Assembly (see Figure 3-3)
4. Locate the UV lamp at the rear of the optical bench assembly (see Figure 10-3)
5. Unplug the lamp cable from the power supply connector on the side of the optical bench.
6. Slightly loosen (do not remove) the UV lamp setscrew and pull the lamp from its housing.
7. Install the new lamp in the housing, pushing it all the way in. Leave the UV lamp setscrew loose for now.
8. Turn the analyzer back on and allow it to warm up for at least 15 minutes.
9. Turn the UV detector gain adjustment pot (See Figure 10-3) clockwise to its minimum value. The pot should click softly when the limit is reached.
10. Perform the UV Lamp Adjustment procedure described in Section 10.5, with the following exceptions:

    Slowly rotate the lamp in its housing (up to ¼ turn in either direction) until a **MAXIMUM** value (or 4600 mVDC) is observed.

    - Make sure the lamp is pushed all the way into the housing while performing this rotation.
    - If the **PHOTO_DET** will not drop below 5000 mV while performing this rotation, contact T-API Customer Service for assistance.

    Once a lamp position is found that corresponds to a maximum observed value for **PHOTO_DET**, tighten the lamp setscrew at the approximate maximum value observed.

    If the value of PHOTO**_DET** is not within the range of 4400 – 4600 mV, adjust it accordingly.
11. Replace the cover on the analyzer.

NOTE

The UV lamp contains mercury (Hg), which is considered hazardous waste. The lamp should be disposed of in accordance with local regulations regarding waste containing mercury.

10.7. ADJUSTMENT OR REPLACEMENT OF OZONE GENERATOR UV LAMP

This procedure details the steps for replacement and initial adjustment of the ozone generator lamp. If you are adjusting an existing lamp, skip to Step 8.

1. Turn off the analyzer.
2. Remove the cover from the analyzer.
3. Locate the O_3 generator (see Figure 3-3).

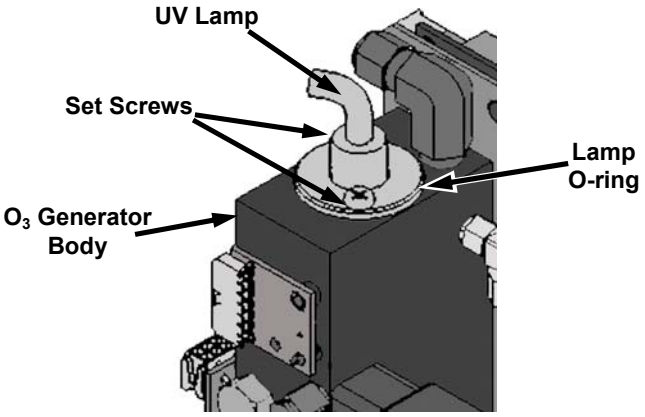


Figure 10-4: O_3 Generator Temperature Thermistor and DC Heater Locations

4. Remove the two setscrews on the top of the O_3 generator and gently pull out the old lamp.
5. Inspect the o-ring beneath the nut and replace if damaged.
6. Install the new lamp in O_3 generator housing.
   - Do not fully tighten the setscrews.
   - The lamp should be able to be rotated in the assembly by grasping the lamp cable.
7. Turn on analyzer and allow it to stabilize for at least 20 minutes.
8. Locate the O_3 generator reference detector adjustment potentiometer.

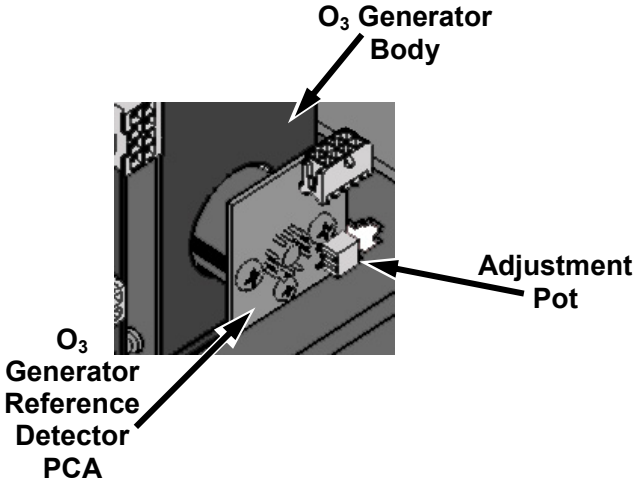
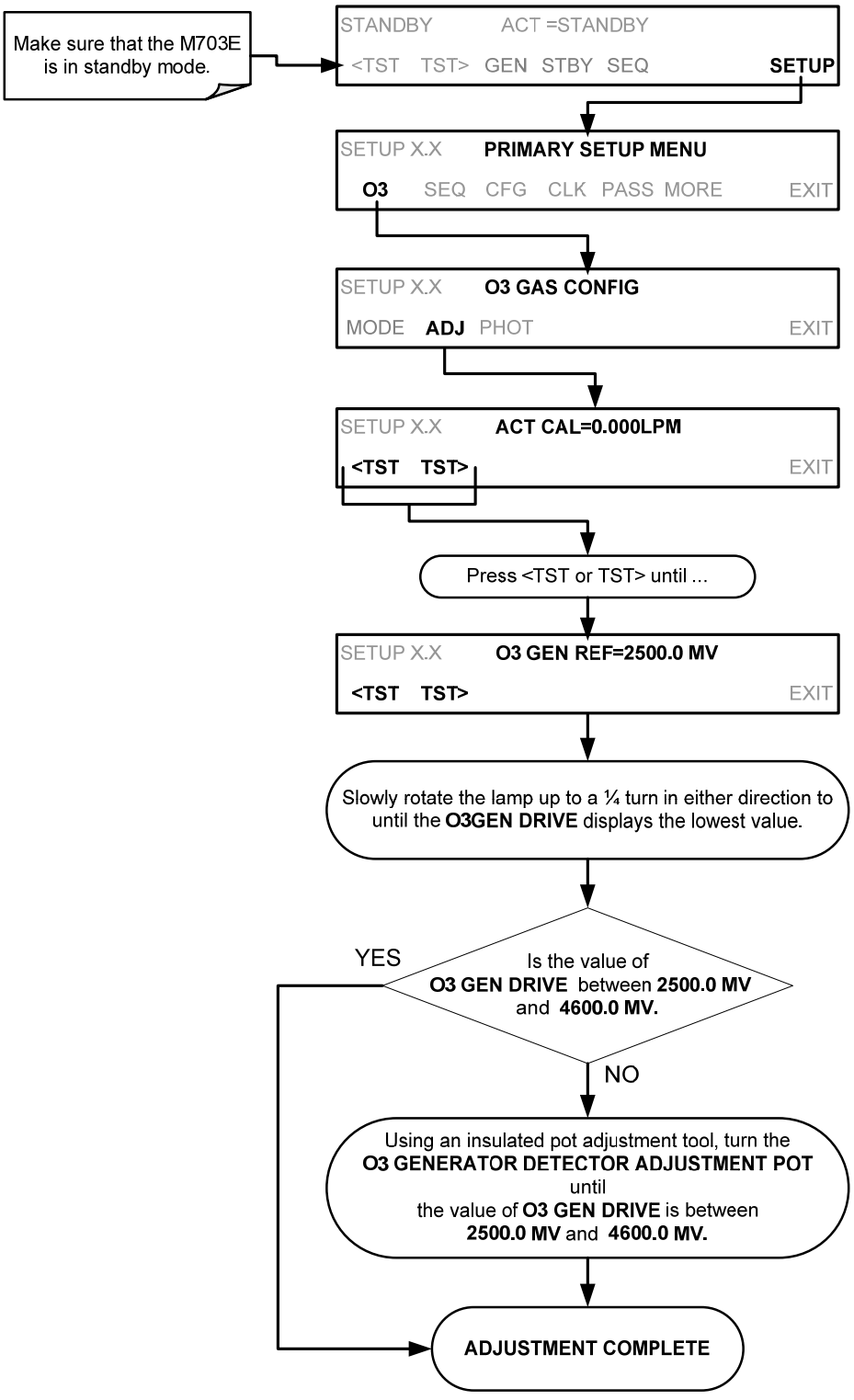


Figure 10-5: Location of O_3 Generator Reference Detector Adjustment Pot

9. Perform the following procedure:


Make sure that the M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X O3 GAS CONFIG
MODE ADJ PHOT EXIT
SETUP X.X ACT CAL=0.000LPM
<TST TST> EXIT
Press <TST or TST> until ...
SETUP X.X O3 GEN REF=2500.0 MV
<TST TST> EXIT
Slowly rotate the lamp up to a ¼ turn in either direction to until the O3GEN DRIVE displays the lowest value.
YES
Is the value of O3 GEN DRIVE between 2500.0 MV and 4600.0 MV.
NO
Using an insulated pot adjustment tool, turn the O3 GENERATOR DETECTOR ADJUSTMENT POT until the value of O3 GEN DRIVE is between 2500.0 MV and 4600.0 MV.
ADJUSTMENT COMPLETE

10. Tighten the two set -screws.
11. Replace the calibrator's cover
12. Perform an auto-leak check (See Section 10.2.1).
13. Calibrate the Ozone Generator calibration (see Section 8.2 Calibrating the O_3 Generator ??)

USER NOTES:

11. GENERAL TROUBLESHOOTING & REPAIR OF THE M703E CALIBRATOR

This section contains a variety of methods for identifying and solving performance problems with the calibrator.

NOTE
The operations outlined in this chapter must be performed by qualified maintenance personnel only.

CAUTION

- **Risk of electrical shock. Some operations need to be carried out with the instrument open and running.**
- **Exercise caution to avoid electrical shocks and electrostatic or mechanical damage to the calibrator.**
- **Do not drop tools into the calibrator or leave those after your procedures.**
- **Do not shorten or touch electric connections with metallic tools while operating inside the calibrator.**
- **Use common sense when operating inside a running calibrator.**

11.1. GENERAL TROUBLESHOOTING

The M703E Photometric Calibrator has been designed so that problems can be rapidly detected, evaluated and repaired. During operation, it continuously performs diagnostic tests and provides the ability to evaluate its key operating parameters without disturbing monitoring operations.

A systematic approach to troubleshooting will generally consist of the following five steps:

14. Note any warning messages and take corrective action as necessary.
15. Examine the values of all TEST functions and compare them to factory values. Note any major deviations from the factory values and take corrective action.
16. Use the internal electronic status LEDs to determine whether the electronic communication channels are operating properly.
    - Verify that the DC power supplies are operating properly by checking the voltage test points on the relay PCA.
    - Note that the calibrator's DC power wiring is color-coded and these colors match the color of the corresponding test points on the relay PCA.
17. Suspect a leak first!
    - Customer service data indicate that the majority of all problems are eventually traced to leaks in the internal pneumatics of the calibrator or the diluent gas and source gases delivery systems.
    - Check for gas flow problems such as clogged or blocked internal/external gas lines, damaged seals, punctured gas lines, a damaged / malfunctioning pumps, etc.

18. Follow the procedures defined in Section 3.4.4 to confirm that the calibrator's vital functions are working (power supplies, CPU, relay PCA, keyboard, PMT cooler, etc.).
    - See Figure 3-3 for general layout of components and sub-assemblies in the calibrator.
    - See the wiring interconnect diagram and interconnect list in Appendix D.

11.1.1. FAULT DIAGNOSIS WITH WARNING MESSAGES

The most common and/or serious instrument failures will result in a warning message being displayed on the front panel. Table 11-1 lists warning messages, along with their meaning and recommended corrective action.

It should be noted that more than two or three warning messages occurring at the same time is often an indication that some fundamental sub-system (power supply, relay PCA, motherboard) has failed rather than an indication of the specific failures referenced by the warnings. In this case, it is recommended that proper operation of power supplies (See Section 11.4.3), the relay PCA (See Section 11.4.6), and the motherboard (See Section11.4.8) be confirmed before addressing the specific warning messages.

The M703E will alert the user that a Warning Message is active by displaying the keypad label MSG on the Front Panel. In this case, the Front panel display will look something like the following:

The calibrator will also alert the user via the Serial I/O COM port(s) and cause the FAULT LED on the front panel to blink.

To view or clear the various warning messages press:

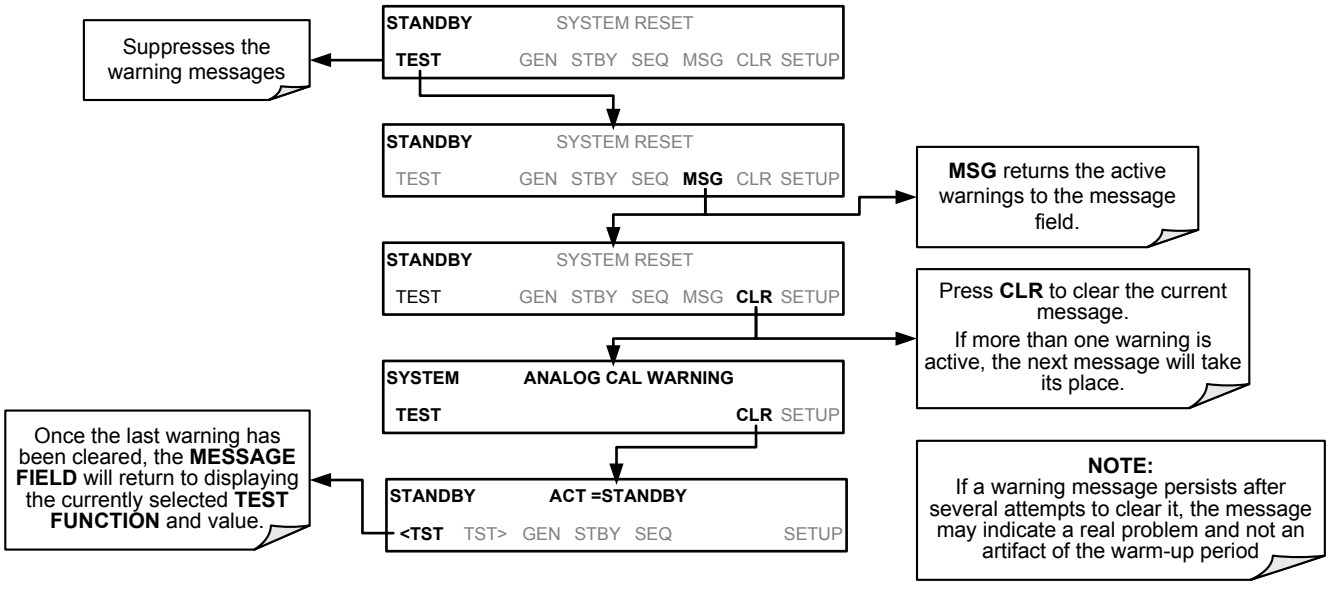

Suppresses the warning messages
STANDBY SYSTEM RESET
TEST GEN STBY SEQ MSG CLR SETUP
STANDBY SYSTEM RESET
TEST GEN STBY SEQ MSG CLR SETUP
MSG returns the active warnings to the message field.
STANDBY SYSTEM RESET
TEST GEN STBY SEQ MSG CLR SETUP
Press CLR to clear the current message.
If more than one warning is active, the next message will take its place.
SYSTEM ANALOG CAL WARNING
TEST CLR SETUP
Once the last warning has been cleared, the MESSAGE FIELD will return to displaying the currently selected TEST FUNCTION and value.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
NOTE:
If a warning message persists after several attempts to clear it, the message may indicate a real problem and not an artifact of the warm-up period

Table 11-1: Front Panel Warning Messages

WARNING	FAULT CONDITION	POSSIBLE CAUSES
CONFIG INITIALIZED	Configuration and Calibration data reset to original Factory state.	- Failed Disk on Chip - User has erased configuration data
DATA INITIALIZED	Data Storage in iDAS was erased.	- Failed Disk-on-Chip. - User cleared data.
FRONT PANEL WARN	The CPU is unable to Communicate with the Front Panel Display Keyboard	- *WARNING* only appears on Serial I/O COM Port(s) - Front Panel Display will be frozen, blank or will not respond. - Failed Keyboard - I^2C Bus failure - Loose Connector/Wiring
LAMP DRIVER WARN	The CPU is unable to communicate with either the O_3 generator or photometer lamp I^2C driver chip.	- I^2C has failed
O3 GEN LAMP TEMP WARNING	IZS Ozone Generator Temp is outside of control range of 48°C ± 3°C.	- No IZS option installed, instrument improperly configured - O_3 generator heater - O_3 generator temperature sensor - Relay controlling the O3 generator heater - Entire Relay PCA - I2C Bus
O3 GEN REFERENCE WARNING[1]	The O_3 generator's reference detector output has dropped below 50 mV.[1]	Possible failure of: - O_3 generator UV Lamp - O_3 generator reference detector - O_3 generator lamp power supply - I^2C bus
O3 PUMP WARNING[1]	The photometer pump failed to turn on within the specified timeout period (default = 30 sec.).	- Failed Pump - Problem with Relay PCA - 12 VDC power supply problem
PHOTO LAMP TEMP WARNING	The photometer lamp temp is < 51°C or >61°C.	Possible failure of: - Bench lamp heater - Bench lamp temperature sensor - Relay controlling the bench heater - Entire Relay PCA - I^2C Bus - Hot" Lamp
PHOTO LAMP STABILITY WARNING	Value output during the Photometer's reference cycle changes from measurements to measurement more than 25% of the time.	- Faulty UV source lamp - Noisy UV detector - Faulty UV lamp power supply - Faulty ± 15 VDC power supply
PHOTO REFERENCE WARNING	Occurs when Ref is <2500 mVDC or >4950 mVDC.	Possible failure of: - UV Lamp - UV Photo-Detector Preamp
REAR BOARD NOT DET	Mother Board not detected on power up.	- THIS WARNING only appears on Serial I/O COM Port(s) Front Panel Display will be frozen, blank or will not respond. - Failure of Mother Board

(table continued)

Table 11-1: Front Panel Warning Messages (cont.)

WARNING	FAULT CONDITION	POSSIBLE CAUSES
RELAY BOARD WARN	The CPU cannot communicate with the Relay PCA.	- I^2C Bus failure - Failed relay PCA - Loose connectors/wiring
SYSTEM RESET	The computer has rebooted.	- This message occurs at power on. - If it is confirmed that power has not been interrupted: - Failed +5 VDC power - Fatal error caused software to restart - Loose connector/wiring

11.1.2. FAULT DIAGNOSIS WITH TEST FUNCTIONS

Besides being useful as predictive diagnostic tools, the test functions viewable from the calibrators front panel can be used to isolate and identify many operational problems when combined with a thorough understanding of the calibrators Theory of Operation (see Chapter 9).

The acceptable ranges for these test functions are listed in the "Nominal Range" column of the calibrator Final Test and Validation Data Sheet shipped with the instrument. Values outside these acceptable ranges indicate a failure of one or more of the calibrator's subsystems. Functions whose values are still within the acceptable range but have significantly changed from the measurement recorded on the factory data sheet may also indicate a failure.

A worksheet has been provided in Appendix C to assist in recording the value of these Test Functions.

Table 11-2 contains some of the more common causes for these values to be out of range.

Table 11-2: Test Functions - Indicated Failures

TEST FUNCTION	DIAGNOSTIC RELEVANCE AND CAUSES OF FAULT CONDITIONS.
O3 GEN REF[1]	Possible causes of faults are the same as **O3 GEN REFERENCE WARNING** from Table 11-1
OUTPUT FLOW	Gas flow problems directly affect the concentration accuracy of the M703E's O_3 calibration gases. This number is computed using data from the calibrator's - Check for Gas Flow problems. - Check the pressure regulator
O3 GEN DRIVE	Check the O_3 generator heater and temperature sensors Possible causes of faults are the same as **O3 GEN LAMP TEMP WARNING** from Table 11-1
O3 LAMP TEMP	Incorrect Lamp temperature can affect the efficiency and durability of the O_3 generators UV lamp. Possible causes of faults are the same as **O3 GEN LAMP TEMP WARNING** from Table 11-1
REG PRESSURE	Same as **REGULATOR PRESSURE WARNING** from Table 11-1
BOX TEMP	If the Box Temperature is out of range, make sure that the: Box Temperature typically runs ~7°C warmer than ambient temperature. - The Exhaust-Fan is running - The there is sufficient open space to the side and rear of instrument to allow adequate ventilation.

(table continued)

Table 11-2: Test Functions - Indicated Failures

TEST FUNCTION	DIAGNOSTIC RELEVANCE AND CAUSES OF FAULT CONDITIONS.
PHOTO MEASURE & PHOTO REFERENCE	If the value displayed is too high the UV Source has become brighter. Adjust the variable gain potentiometer on the UV Preamp Board in the optical bench. If the value displayed is too low: - < 100mV – Bad UV lamp or UV lamp power supply. - < 2000mV – Lamp output has dropped, adjust UV Preamp Board or replace lamp. If the value displayed is constantly changing: - Bad UV lamp. - Defective UV lamp power supply. - Failed I^2C Bus. If the PHOTO REFERENCE value changes by more than 10mV between zero and span gas: - Defective/leaking switching valve.
PHOTO FLOW	Gas flow problems directly affect the accuracy of the photometer measurements and therefore the concentration accuracy of cal gas mixtures involving O_3 and GPT mixtures. - Check for Gas Flow problems.
PHOTO LAMP TEMP	Poor photometer temp control can cause instrument noise, stability and drift. Temperatures outside of the specified range or oscillating temperatures are cause for concern. Possible causes of faults are the same as **PHOTO LAMP TEMP WARNING from** Table 11-1
PHOTO SPRESS	The pressure of the gas in the photometer's sample chamber is used to calculate the concentration of O_3 in the gas stream. Incorrect sample pressure can cause inaccurate readings. - Check for Gas Flow problems. See Section Table 11-1.
PHOTO STEMP	The temperature of the gas in the photometer's sample chamber is used to calculate the concentration of O_3 in the gas stream. Incorrect sample temperature can cause inaccurate readings. Possible causes of faults are: - Bad bench lamp heater - Failed sample temperature sensor - Failed relay controlling the bench heater - Failed Relay PCA - I^2C Bus malfunction - Hot Lamp
PHOTO SLOPE	Values outside range indicate: Contamination of the Zero Air or Span Gas supply. Instrument is miss-calibrated. Blocked Gas Flow. Faulty Sample Pressure Sensor or circuitry. Bad/incorrect Span Gas concentration.
PHOTO OFFSET	Values outside range indicate: Contamination of the Zero Air supply.
TIME	Time of Day clock is too fast or slow. To adjust see Section 6.7.2. Battery in clock chip on CPU board may be dead.

11.1.3. USING THE DIAGNOSTIC SIGNAL I/O FUNCTION

The Signal I/O parameters found under the DIAG Menu combined with a thorough understanding of the instruments Theory of Operation (found in Chapter 9) are useful for troubleshooting in three ways:

- The technician can view the raw, unprocessed signal level of the calibrator's critical inputs and outputs.
- Many of the components and functions that are normally under algorithmic control of the CPU can be manually exercised.
- The technician can directly control the signal level Analog and Digital Output signals.

This allows the technician to observe systematically the effect of directly controlling these signals on the operation of the calibrator. Figure 11-1 is an example of how to use the Signal I/O menu to view the raw voltage of an input signal or to control the state of an output voltage or control signal. The specific parameter will vary depending on the situation.

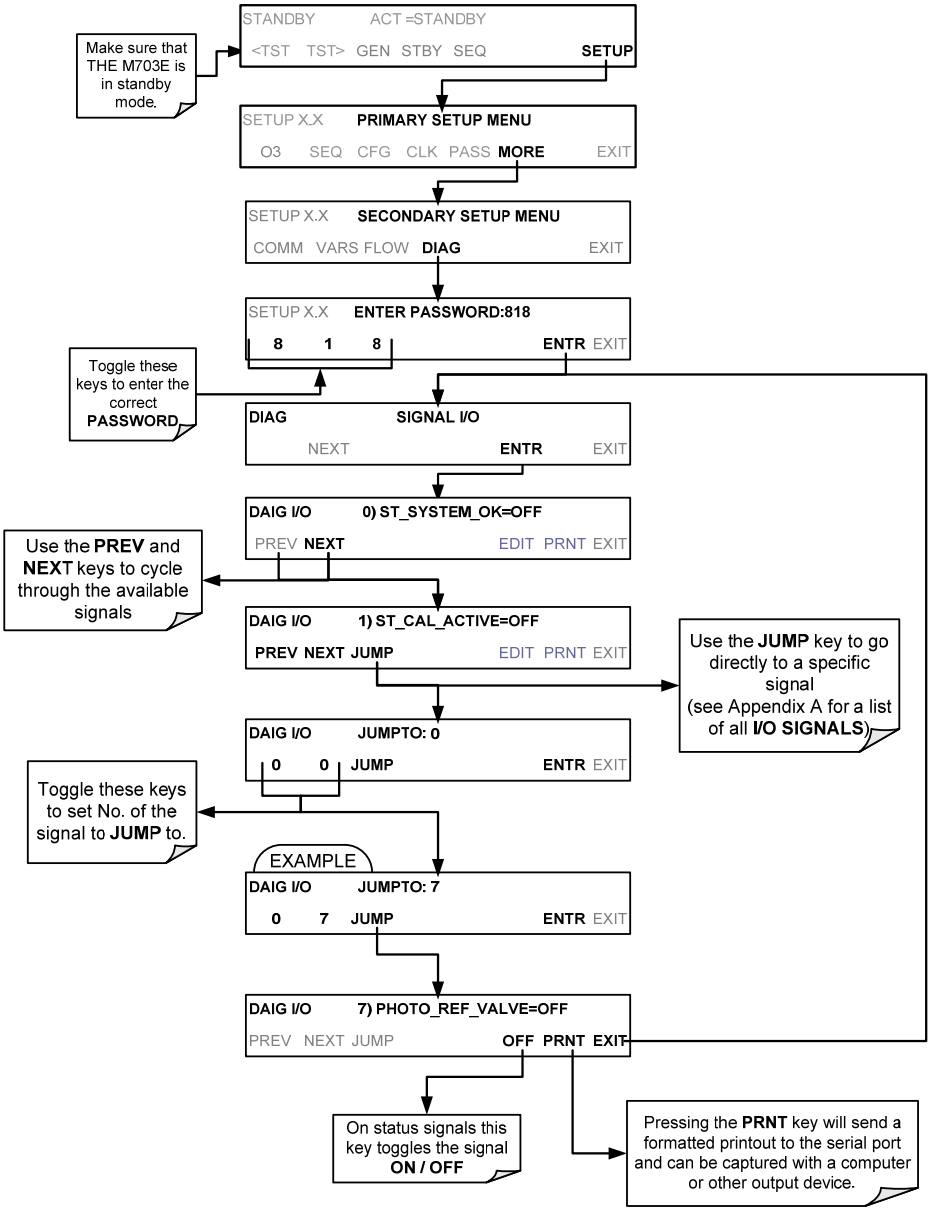

Make sure that THE M703E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS FLOW DIAG EXIT
SETUP X.X ENTER PASSWORD:818
8 1 8 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
NEXT ENTR EXIT
DAIG I/O 0) ST_SYSTEM_OK=OFF
PREV NEXT EDIT PRNT EXIT
Use the PREV and NEXT keys to cycle through the available signals
DAIG I/O 1) ST_CAL_ACTIVE=OFF
PREV NEXT JUMP EDIT PRNT EXIT
Use the JUMP key to go directly to a specific signal (see Appendix A for a list of all I/O SIGNALS)
DAIG I/O JUMPTO: 0
0 0 JUMP ENTR EXIT
Toggle these keys to set No. of the signal to JUMP to.
EXAMPLE
DAIG I/O JUMPTO: 7
0 7 JUMP ENTR EXIT
DAIG I/O 7) PHOTO_REF_VALVE=OFF
PREV NEXT JUMP OFF PRNT EXIT
On status signals this key toggles the signal ON / OFF
Pressing the PRNT key will send a formatted printout to the serial port and can be captured with a computer or other output device.

Figure 11-1: Example of Signal I/O Function

11.2. USING THE ANALOG OUTPUT TEST CHANNEL

The signals available for output over the M703E's analog output channel can also be used as diagnostic tools. See Section 6.9 for instruction on activating the analog output and selecting a function.

Table 11-3: Test Channel Outputs as Diagnostic Tools

TEST CHANNEL	DESCRIPTION	ZERO	FULL SCALE	CAUSES OF EXTREMELY HIGH / LOW READINGS
NONE	**TEST CHANNEL IS TURNED OFF**			
O3 PHOTO MEAS	The raw output of the photometer during its measure cycle	0 mV	5000 mV*	If the value displayed is: - >5000 mV: The UV source has become brighter. Adjust the UV Detector Gain potentiometer. - < 100mV – Bad UV lamp or UV lamp power supply. - < 2000mV – Lamp output has dropped, adjust UV Preamp Board or replace lamp. If the value displayed is constantly changing: - Bad UV lamp. - Defective UV lamp power supply. - Failed I^2C Bus.
O3 PHOTO REF	The raw output of the photometer during its reference cycle	0 mV	5000 mV	If the PHOTO REFERENCE value changes by more than 10mV between zero and span gas: - Defective/leaking M/R switching valve.
O3 GEN REF	The raw output of the O_3 generator's reference detector	0 mV	5000 mV	Possible causes of faults are the same as **OUTPUT FLOW** from Table 11-2.
OUTPUT FLOW	Output flow rate (computed from regulator pressure).	0 LPM	6.000 LPM	Possible causes of faults are the same as **O3 GEN REFERENCE WARNING** from Table 11-1
SAMPLE PRESSURE	The pressure of gas in the photometer absorption tube	0 "Hg	40 "Hg-In-A	Check for Gas Flow problems.
SAMPLE FLOW	The gas flow rate through the photometer	0 cm^3/min	1000 cc/m	Check for Gas Flow problems.
SAMPLE TEMP	The temperature of gas in the photometer absorption tube	0 C°	70 C°	Possible causes of faults are the same as **PHOTO STEMP** from Table 11-2
PHOTO LAMP TEMP	The temperature of the photometer UV lamp	0 C°	70 C°	Possible failure of: - Bench lamp heater - Bench lamp temperature sensor - Relay controlling the bench heater - Entire Relay PCA - I^2C Bus - Hot" Lamp
O3 LAMP TEMP	The temperature of the O_3 generator's UV lamp	0 mV	5000 mV	Same as **PHOTO LAMP TEMP WARNING from** Table 11-1
CHASSIS TEMP	The temperature inside the M703E's chassis (same as **BOX TEMP**)	0 C°	70 C°	Possible causes of faults are the same as **BOX TEMP** from Table 11-2
O3 PHOTO CONC	The current concentration of O_3 being measured by the photometer.	- - -		- I^2C Bus malfunction - Gas flow problem through the photometer. - Electronic failure of the photometer subsystems - Failure or pressure / temperature sensors associated with the photometer - Bad/incorrect Span Gas concentration - Contamination of the Zero Air supply. - Malfunction of the O_3 generator. - Internal A/D converter problem

11.3. USING THE INTERNAL ELECTRONIC STATUS LEDS

Several LEDs are located inside the instrument to assist in determining if the calibrators CPU, I^2C bus and Relay PCA are functioning properly.

11.3.1. CPU STATUS INDICATOR

DS5, a red LED, that is located on upper portion of the motherboard, just to the right of the CPU board, flashes when the CPU is running the main program loop. After power-up, approximately 30 – 60 seconds, DS5 should flash on and off. If characters are written to the front panel display but DS5 does not flash then the program files have become corrupted, contact customer service because it may be possible to recover operation of the calibrator. If after 30 – 60 seconds neither DS5 is flashing and no characters have been written to the front panel display then the CPU is bad and must be replaced.

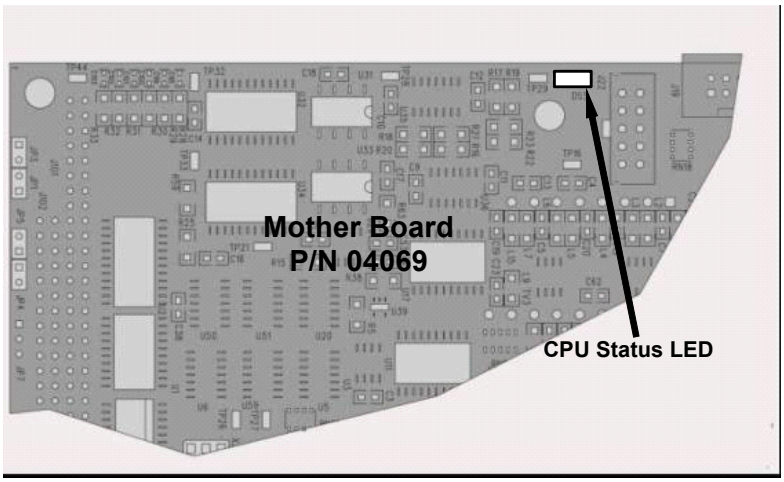


Figure 11-2: CPU Status Indicator

11.3.2. RELAY PCA STATUS LEDS

There are seven LEDs located on the Relay PCA. Some are not used on this model.

11.3.2.1. I^2C Bus Watchdog Status LEDs

The most important is D1 (see, which indicates the health of the I^2C bus.

Table 11-4: Relay PCA Watchdog LED Failure Indications

LED	Function	Fault Status	Indicated Failure(s)
D1 (Red)	I^2C bus Health (Watchdog Circuit)	Continuously ON or Continuously OFF	Failed/Halted CPU Faulty Mother Board, Keyboard or Relay PCA Faulty Connectors/Wiring between Mother Board, Keyboard or Relay PCA Failed/Faulty +5 VDC Power Supply (PS1)

If D1 is blinking, then the other LEDs can be used in conjunction with **DIAG** Menu Signal I/O to identify hardware failures of the relays and switches on the Relay.

11.3.2.2. O_3 Status LEDs

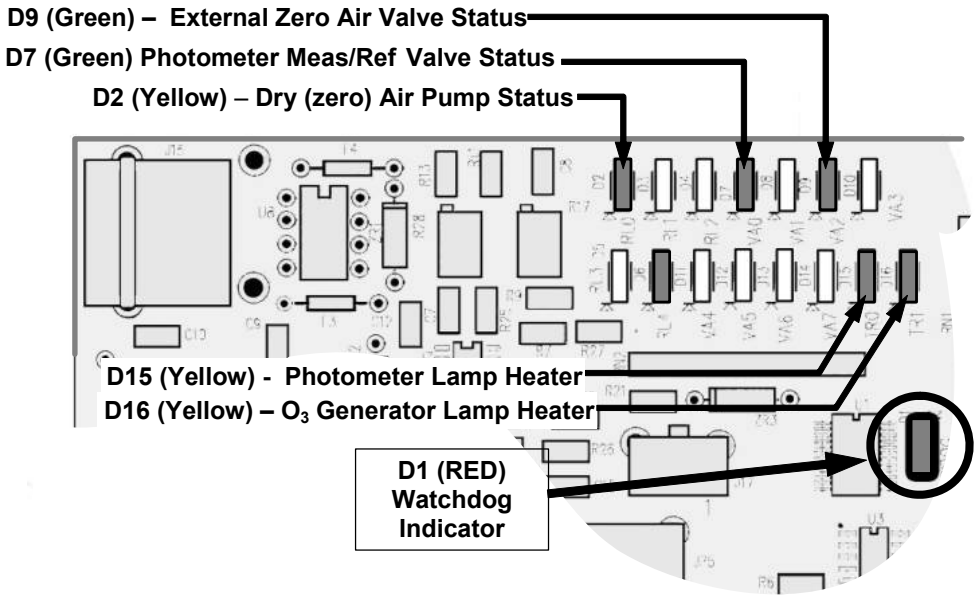

D9 (Green) – External Zero Air Valve Status
D7 (Green) Photometer Meas/Ref Valve Status
D2 (Yellow) – Dry (zero) Air Pump Status
D15 (Yellow) - Photometer Lamp Heater
D16 (Yellow) – O3 Generator Lamp Heater
D1 (RED) Watchdog Indicator

Figure 11-3: Relay PCA Status LEDS Used for Troubleshooting

Table 11-5: Relay PCA Status LED Failure Indications

LED	FUNCTION	SIGNAL I/O PARAMETER		DIAGNOSTIC TECHNIQUE
		ACTIVATED BY	VIEW RESULT	
D2 Yellow	Status of AC powered Dry Air Pump	**ZERO_AIR_PUMP**	N/A	Pump should start /stop • Failed pump • Failed AC Relay on Relay PCA • Failed Relay PCA • Faulty AC Power Supply (PS2) • Faulty Connectors/Wiring
D7 Green	Photometer Meas/Ref Valve	**PHOTO_REF_VALVE**	N/A	Valve should audibly change states. If not: • Failed Valve • Failed Relay Drive IC on Relay PCA • Failed Relay PCA • Faulty +12 VDC Supply (PS2) • Faulty Connectors/Wiring
D9 Green	Status of DC powered Photometer Pump	**O3-PUMP-ON**	N/A	Pump should start /stop • Failed pump • Failed Drive IC on Relay PCA • Failed Relay PCA • Faulty AC Power Supply (PS2) • Faulty Connectors/Wiring
D15 Yellow	Photometer Heater Status	**PHOTO_LAMP_HEATER**	**PHOTO_LAMP_TEMP**	Voltage displayed should change. If not: • Failed Heater • Faulty Temperature Sensor • Failed AC Relay • Faulty Connectors/Wiring
D16 Green	O_3 Generator Heater Status	**O3_GEN_HEATER**	**O3_GEN_TEMP**	

11.4. SUBSYSTEM CHECKOUT

The preceding sections of this manual discussed a variety of methods for identifying possible sources of failures or performance problems within the M703E calibrator. In most cases, this includes a list of possible components or subsystems that might be the source of the problem. This section describes how to check individual components or subsystems to determine if which is actually the cause of the problem being investigated.

11.4.1. VERIFY SUBSYSTEM CALIBRATION

A good first step when troubleshooting the operation of the M703E calibrator is to verify that its major subsystems are properly calibrated. These are:

- Test Channel D → A conversion (see Section 6.9.2).
- Gas pressure calibration (see Section 8.3).

When optional O_3 components are installed, you should also check:

- Photometer calibration (see Section 8.1).
- O_3 generator calibration (see Section 8.2).

11.4.2. AC MAIN POWER

The M703E calibrator's electronic systems will operate with any of the specified power regimes. As long as system is connected to 100-120 VAC or 220-240 VAC at either 50 or 60 Hz it will turn on and after about 30 seconds show a front panel display.

- Internally, the status LEDs located on the Relay PCA, Motherboard and CPU should turn on as soon as the power is supplied.
- If they do not, check the circuit breaker built into the ON/OFF switch on the instruments front panel

	CAUTION **SHOULD THE AC POWER CIRCUIT BREAKER TRIP, INVESTIGATE AND CORRECT THE CONDITION CAUSING THIS SITUATION BEFORE TURNING THE CALIBRATOR BACK ON.**

11.4.3. DC POWER SUPPLY

If you have determined that the calibrator's AC mains power is working, but the unit is still not operating properly, there may be a problem with one of the instrument's switching power supplies. The supplies can have two faults, namely no DC output, and noisy output.

To assist tracing DC Power Supply problems, the wiring used to connect the various printed circuit assemblies and DC Powered components and the associated test points on the relay PCA follow a standard color-coding scheme as defined in the following table.

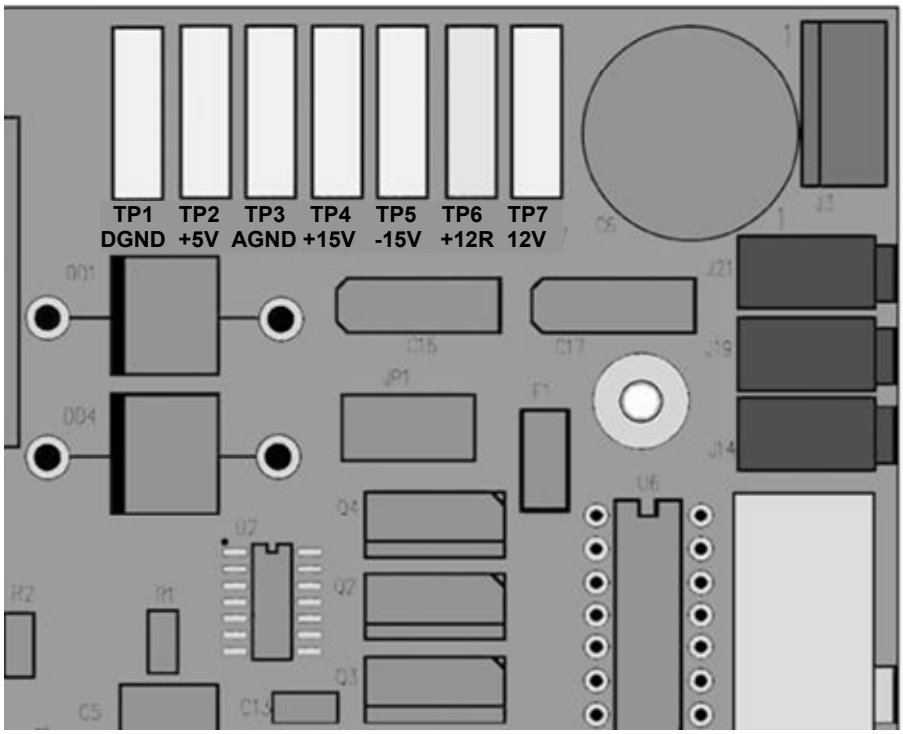


Figure 11-4: Location of DC Power Test Points on Relay PCA

Table 11-6: DC Power Test Point and Wiring Color Codes

NAME	TEST POINT#	TP AND WIRE COLOR
Dgnd	**1**	Black
+5V	**2**	Red
Agnd	**3**	Green
+15V	**4**	Blue
-15V	**5**	Yellow
+12R	**6**	Purple
+12V	**7**	Orange

A voltmeter should be used to verify that the DC voltages are correct per the values in the table below, and an oscilloscope, in AC mode, with band limiting turned on, can be used to evaluate if the supplies are producing excessive noise (> 100 mV p-p).

Table 11-7: DC Power Supply Acceptable Levels

POWER SUPPLY ASSY	VOLTAGE	CHECK RELAY PCA TEST POINTS				MIN V	MAX V
		FROM TEST POINT		TO TEST POINT			
		NAME	#	NAME	#		
PS1	+5	Dgnd	1	+5	2	4.8	5.25
PS1	+15	Agnd	3	+15	4	13.5	16V
PS1	-15	Agnd	3	-15V	5	-14V	-16V
PS1	Agnd	Agnd	3	Dgnd	1	-0.05	0.05
PS1	Chassis	Dgnd	1	Chassis	N/A	-0.05	0.05
PS2	+12	+12V Ret	6	+12V	7	11.75	12.5
PS2	+12 V ret	+12V Ret	6	Dgnd	1	-0.05	0.05

11.4.4. I^2C BUS

Operation of the I^2C bus can be verified by observing the behavior of D1 on the relay PCA & D2 on the valve driver PCA in conjunction with the performance of the front panel display.

Assuming that the DC power supplies are operating properly the I^2C bus is operating properly if:

- If D1 on the relay PCA and D2 of the Valve Driver PCA are flashing, or
- Pressing a key on the front panel results in a change to the display.

There is a problem with the I^2C bus if

- Both D1 on the relay PCA and D2 of the Valve Driver PCA are ON/OFF Constantly and pressing a key on the front panel DOES NOT results in a change to the display.

If the keyboard interface is working but either of the two Watchdog LEDs is not flashing, the problem may be a wiring issue between the board and the motherboard

11.4.5. KEYBOARD/DISPLAY INTERFACE

The front panel keyboard, display and Keyboard Display Interface PCA can be verified by observing the operation of the display when power is applied to the instrument and when a key is pressed on the front panel. Assuming that there are no wiring problems and that the DC power supplies are operating properly:

- The vacuum fluorescent display is good if on power-up a "-" character is visible on the upper left hand corner of the display.
- If there is no "-" character on the display at power-up and D1 on the Relay PCA or D2 on the valve driver PCA is flashing then the Keyboard/Display Interface PCA is bad.
- The CPU Status LED, DS5, is flashing, but there is no "-" character on the display at power-up

- If the calibrator starts operation with a normal display but pressing a key on the front panel does not change the display, then there are three possible problems.
  - One or more of the keys are bad,
  - The interrupt signal between the Keyboard Display interface and the motherboard is broken, or
  - The Keyboard Display Interface PCA is bad.

11.4.6. RELAY PCA

The Relay PCA can be most easily checked by observing the condition of the status LEDs located along its upper edge (see Section 11.3.2 and Figure 11-3:Relay PCA Status LEDS Used for Troubleshooting), and using the **SIGNAL I/O** submenu under the **DIAG** menu (see Section 11.1.3) to toggle each LED **ON** or **OFF.**

If D1 on the Relay PCA is flashing and the status indicator for the output in question (Pump power, Heater power, Valve Drive, etc.) toggles properly using the Signal I/O function, then the associated control device on the Relay PCA is bad. Several of the control devices are in sockets and can be easily replaced. The table below lists the control device associated with a particular function.

Table 11-8: Relay PCA Control Devices

FUNCTION	CONTROL DEVICE	IN SOCKET
UV Lamp Heater	Q2	No
O_3 Gen Heater	Q3	No
All Valves	U5	Yes
AC Dry air Pump	K1	No
DC Photometer Pump	U1	No

11.4.7. PHOTOMETER O3 GENERATOR PRESSURE /FLOW SENSOR ASSEMBLY

This assembly is only present in calibrators with O_3 generator and/or photometer options installed. The pressure/flow sensor PCA, located at the rear of the instrument between the O_3 generator and the photometer pump (see Figure 3-3) can be checked with a Voltmeter. The following procedure assumes that the wiring is intact and that the motherboard as well as the power supplies are operating properly:

BASIC PCA OPERATION:

- Measure the voltage across C1 it should be 5 VDC ± 0.25 VDC. If not then the board is bad
- Measure the voltage between TP2 and TP1 C1 it should be 1o VDC ± 0.25 VDC. If not then the board is bad.

PHOTOMETER PRESSURE SENSOR:

1. Measure the pressure on the inlet side of S1 with an external pressure meter.
2. Measure the voltage across TP4 and TP1.
   - The expected value for this signal should be:

$$\text{Expected mVDC} = \left(\frac{\text{Pressure}}{30.0_{\text{Hg-In-A}}} \times 4660_{\text{mvDC}}\right) + 250_{\text{mvDC}} \quad \pm 10\%_{\text{rdg}}$$

   EXAMPLE: If the measured pressure is 20 Hg-in-A, the expected voltage level between TP4 and TP1 would be between 2870 mVDC and 3510 mVDC.

   EXAMPLE: If the measured pressure is 25 Hg-in-A, the expected voltage level between TP4 and TP1 would be between 3533 mVDC and 4318 mVDC.

   - If this voltage is out of range, then either pressure transducer S1 is bad, the board is bad or there is a pneumatic failure preventing the pressure transducer from sensing the absorption cell pressure properly.

O_3 GENERATOR PRESSURE SENSOR

1. Measure the pressure on the inlet side of S2 with an external pressure meter.
2. Measure the voltage across TP5 and TP1.
   - The expected value for this signal should be:

$$\text{Expected mVDC} = \left(\frac{\text{Pressure}}{34.18_{\text{psig}}} \times 4250_{\text{mvDC}}\right) + 750_{\text{mvDC}} \quad \pm 10\%_{\text{rdg}}$$

   EXAMPLE: If the measured pressure is 25 psig, the expected voltage level between TP4 and TP1 would be between 3470 mVDC and 4245 mVDC.

   EXAMPLE: If the measured pressure is 30 psig, the expected voltage level between TP4 and TP1 would be between 4030 mVDC and 4930 mVDC.

   - If this voltage is out of range, then either pressure transducer S1 is bad, the board is bad or there is a pneumatic failure preventing the pressure transducer from sensing the absorption cell pressure properly.

PHOTOMETER FLOW SENSOR

- Measure the voltage across TP3 and TP1.
  - With proper flow (800 cc^3/min through the photometer), this should be approximately 4.5V (this voltage will vary with altitude).
  - With flow stopped (photometer inlet disconnected or pump turned OFF) the voltage should be approximately 1V.
  - If the voltage is incorrect, the flow sensor S3 is bad, the board is bad or there is a leak upstream of the sensor.

11.4.8. MOTHERBOARD

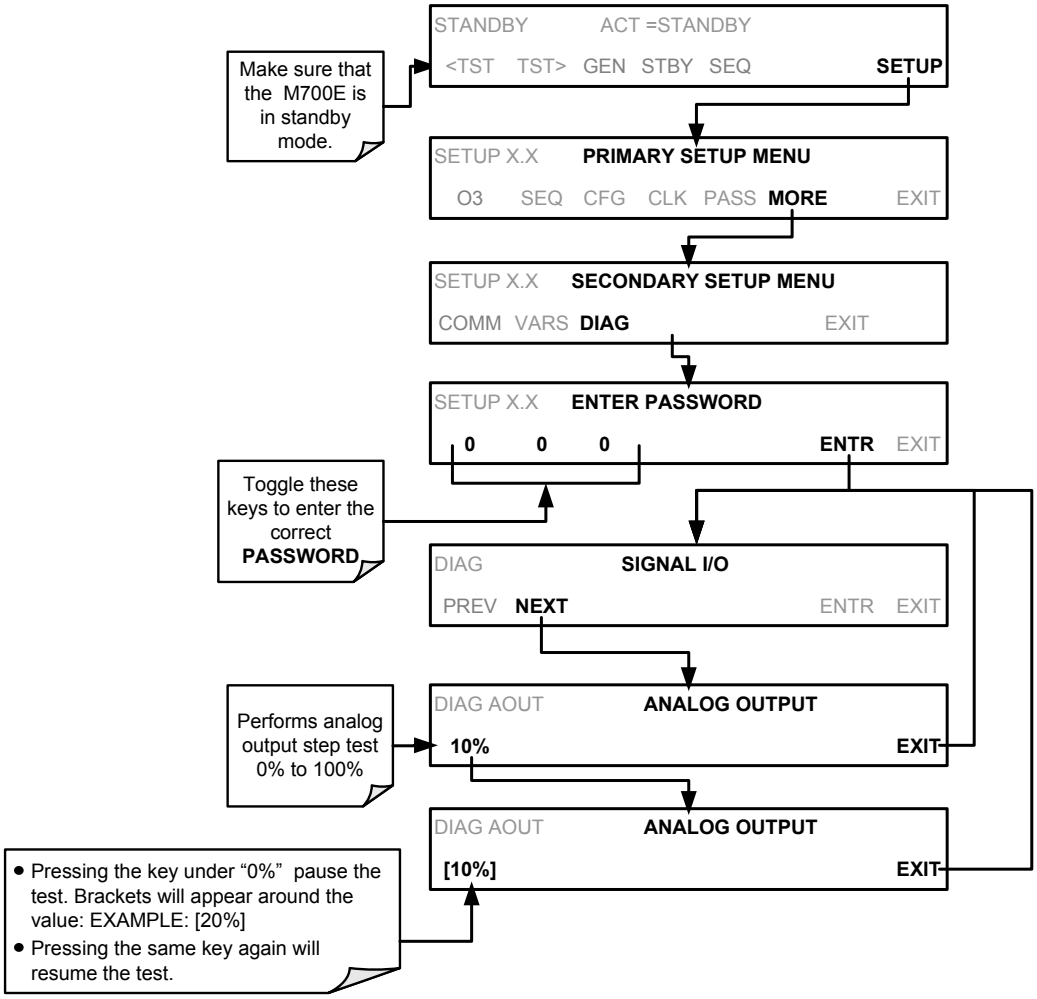
11.4.8.1. A/D Functions

The simplest method to check the operation of the A-to-D converter on the motherboard is to use the Signal I/O function under the DIAG menu to check the two A/D reference voltages and input signals that can be easily measured with a voltmeter.

1. Use the Signal I/O function (See Section 11.1.3 and Appendix A) to view the value of **REF_4096_MV** and **REF_GND**. If both are within 3 mV of nominal (4096 and 0), and are stable, ±0.5 mV then the basic A/D is functioning properly. If not then the motherboard is bad.
2. Choose a parameter in the Signal I/O function such as **PHOTO_LAMP_DRIVE, O3_GEN_TEMP** or **PHOTO_FLOW**.
   - Compare these voltages at their origin (see the interconnect drawing and interconnect list in Appendix D) with the voltage displayed through the signal I/O function.
   - If the wiring is intact but there is a large difference between the measured and displayed voltage (±10 mV) then the motherboard is bad.

11.4.8.2. Test Channel / Analog Outputs Voltage

To verify that the analog output is working properly, connect a voltmeter to the output in question and perform an analog output step test as follows:


Make sure that the M700E is in standby mode.
STANDBY ACT =STANDBY
<TST TST> GEN STBY SEQ SETUP
SETUP X.X PRIMARY SETUP MENU
O3 SEQ CFG CLK PASS MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X ENTER PASSWORD
0 0 0 ENTR EXIT
Toggle these keys to enter the correct PASSWORD
DIAG SIGNAL I/O
PREV NEXT ENTR EXIT
Performs analog output step test 0% to 100%
DIAG AOUT ANALOG OUTPUT
10% EXIT
DIAG AOUT ANALOG OUTPUT
[10%] EXIT
• Pressing the key under "0%" pause the test. Brackets will appear around the value: EXAMPLE: [20%]
• Pressing the same key again will resume the test.

For each of the steps the output should be within 1% of the nominal value listed in the table below except for the 0% step, which should be within 0mV ±2 to 3 mV. Make sure you take into account any offset that may have been programmed into channel (See Section 6.9.1.5).

Table 11-9: Analog Output Test Function - Nominal Values Voltage Outputs

		FULL SCALE OUTPUT OF VOLTAGE RANGE (see Section 6.9.1.3)			
		100MV	1V	5V	10V
STEP	%	NOMINAL OUTPUT VOLTAGE			
1	0	0	0	0	0
2	20	20 mV	0.2	1	2
3	40	40 mV	0.4	2	4
4	60	60 mV	0.6	3	6
5	80	80 mV	0.8	4	8
6	100	100 mV	1.0	5	10

If one or more of the steps fails to be within these ranges, it is likely that there has been a failure of the either or both of the DACs and their associated circuitry on the motherboard.

11.4.8.3. Status Outputs

To test the status output electronics:

1. Connect a jumper between the "D" pin and the "▽" pin on the status output connector.
2. Connect a 1000 ohm resistor between the "+" pin and the pin for the status output that is being tested.
3. Connect a voltmeter between the "▽" pin and the pin of the output being tested (see table below).
4. Under the **DIAG→ SIGNAL I/O** menu (See Section11.1.3), scroll through the inputs and outputs until you get to the output in question.
5. Alternately, turn on and off the output noting the voltage on the voltmeter.
   - It should vary between 0 volts for ON and 5 volts for OFF.

Table 11-10: Status Outputs Check

PIN (LEFT TO RIGHT)	STATUS
1	ST_SYSTEM_OK
2	SPARE
3	ST_CAL_ACTIVE
4	ST_DIAG_MODE
5	ST_TEMP_ALARM
6	ST_PRESS_ALARM
7 and 8	SPARE

11.4.8.4. Control Inputs

Table 11-11: M703E Control Input Pin Assignments and Corresponding Signal I/O Functions

CONNECTOR	INPUT	CORRESPONDING I/O SIGNAL
Top	A	CONTROL_IN_1
Top	B	CONTROL_IN_2
Top	C	CONTROL_IN_3
Top	D	CONTROL_IN_4
Top	E	CONTROL_IN_5
Top	F	CONTROL_IN_6
Bottom	G	CONTROL_IN_7
Bottom	H	CONTROL_IN_8
Bottom	I	CONTROL_IN_9
Bottom	J	CONTROL_IN_10
Bottom	K	CONTROL_IN_11
Bottom	L	CONTROL_IN_12

The control input bits can be tested by applying a trigger voltage to an input and watching changes in the status of the associated function under the SIGNAL I/O submenu:

EXAMPLE: to test the "**A**" control input:

1. Under the **DIAG→ SIGNAL I/O** menu (See Section11.1.3), scroll through the inputs and outputs until you get to the output named **0) CONTROL_IN_1**.
2. Connect a jumper from the "**+**" pin on the appropriate connector to the "**U**" on the same connector.
3. Connect a second jumper from the "▽" pin on the connector to the "**A**" pin.
4. The status of **0) CONTROL_IN_1** should change to read "**ON**".

11.4.8.5. Control Outputs

Table 11-12: Control Outputs Pin Assignments and Corresponding Signal I/O Functions Check

PIN (LEFT TO RIGHT)	STATUS
1	**CONTROL_OUT_1**
2	**CONTROL_OUT_2**
3	**CONTROL_OUT_3**
4	**CONTROL_OUT_4**
5	**CONTROL_OUT_5**
6	**CONTROL_OUT_6**
7	**CONTROL_OUT_7**
8	**CONTROL_OUT_8**
9	**CONTROL_OUT_9**
10	**CONTROL_OUT_10**
11	**CONTROL_OUT_11**
12	**CONTROL_OUT_12**

To test the Control Output electronics:

1. Connect a jumper between the "E" pin and the "▽" pin on the status output connector.
2. Connect a 1000 ohm resistor between the "+" pin and the pin for the status output that is being tested.
3. Connect a voltmeter between the "▽" pin and the pin of the output being tested (see Table 11-12).
4. Under the **DIAG→ SIGNAL I/O** menu (See Section11.1.3), scroll through the inputs and outputs until you get to the output in question.
5. Alternately, turn on and off the output noting the voltage on the voltmeter.
   - It should vary between 0 volts for ON and 5 volts for OFF.

11.4.9. CPU

There are two major types of failures associated with the CPU board: complete failure and a failure associated with the Disk-On Chip on the CPU board. If either of these failures occur, contact the factory.

- For complete failures, assuming that the power supplies are operating properly and the wiring is intact, the CPU is bad if on powering the instrument:
- The vacuum fluorescent display shows a dash in the upper left hand corner.
- The CPU Status LED, DS5, is not flashing. (See Section 11.1.4.1.)
- There is no activity from the primary RS-232 port on the rear panel even if "? <ret>" is pressed.
- In some rare circumstances this failure may be caused by a bad IC on the motherboard, specifically U57 the large, 44 pin device on the lower right hand side of the board. If this is true, removing U57 from its socket will allow the instrument to startup but the measurements will be incorrect.
- If the calibrator stops part way through initialization (there are words on the vacuum fluorescent display) then it is likely that the DOC has been corrupted.

11.4.10. RS-232 COMMUNICATIONS

11.4.10.1. General RS-232 Troubleshooting

Teledyne Instruments calibrators use the RS-232 communications protocol to allow the instrument to be connected to a variety of computer-based equipment. RS-232 has been used for many years and as equipment has become more advanced, connections between various types of hardware have become increasingly difficult. Generally, every manufacturer observes the signal and timing requirements of the protocol very carefully.

Problems with RS-232 connections usually center around four general areas:

- Incorrect cabling and connectors. See Section 7.1.2 for connector and pin-out information.
- The BAUD rate and protocol are incorrectly configured. See Section 7.1.3.
- If a modem is being used, additional configuration and wiring rules must be observed. See Section 7.2
- Incorrect setting of the DTE – DCE Switch is set correctly. See Section 7.1.1.
- Verify that cable (03596) that connects the serial COM ports of the CPU to J12 of the motherboard is properly seated

11.4.10.2. Troubleshooting Calibrator/Modem or Terminal Operation

These are the general steps for troubleshooting problems with a modem connected to a Teledyne Instruments calibrator.

- Check cables for proper connection to the modem, terminal or computer.
- Check to make sure the DTE-DCE is in the correct position as described in Section 7.1.1.
- Check to make sure the set up command is correct (See Section 7.2)
- Verify that the Ready to Send (RTS) signal is at logic high. The M703E sets pin 7 (RTS) to greater than 3 volts to enable modem transmission.
- Make sure the BAUD rate, word length, and stop bit settings between modem and calibrator match, See Section 7.1.3.
- Use the RS-232 test function to send "w" characters to the modem, terminal or computer; See Section 7.1.5
- Get your terminal, modem or computer to transmit data to the calibrator (holding down the space bar is one way); the green LED should flicker as the instrument is receiving data.
- Make sure that the communications software or terminal emulation software is functioning properly.

NOTE

Further help with serial communications is available in a separate manual "RS-232 Programming Notes" Teledyne Instruments part number 013500000.

11.4.11. TEMPERATURE PROBLEMS

Individual control loops are used to maintain the set point of the UV lamp and ozone generator. If any of these temperatures are out of range or are poorly controlled, the M703E will perform poorly.

11.4.11.1. Box / Chassis Temperature

The box temperature sensor is mounted to the Motherboard and cannot be disconnected to check its resistance. Rather check the **BOX TEMP** signal using the **SIGNAL I/O** function under the **DIAG** Menu (see Section 11.1.3). This parameter will vary with ambient temperature, but at ~30°C (6-7° above room temperature) the signal should be ~1450 mV.

11.4.11.2. Photometer Sample Chamber Temperature

The temperature of the gas in the photometer sample chamber should read approximately 5.0°C higher than the box temperature.

11.4.11.3. UV Lamp Temperature

There are three possible causes for the UV Lamp temperature to have failed.

- The UV Lamp heater has failed. Check the resistance between pins 5 and 6 on the six-pin connector adjacent to the UV Lamp on the Optical Bench.
  - It should be approximately 30 Ohms.
- Assuming that the I^2C bus is working and that there is no other failure with the Relay board, the FET Driver on the Relay Board may have failed.
  - Using the **PHOTO_LAMP HEATER** parameter under the **SIGNAL I/O** function of the **DIAG** menu, as described above, turn on and off the UV Lamp Heater (D15 on the relay board should illuminate as the heater is turned on).
  - Check the DC voltage present between pin 1 and 2 on J13 of the Relay Board.
  - If the FET Driver has failed, there will be no change in the voltage across pins 1 and 2.
- If the FET Driver Q2 checks out OK, the thermistor temperature sensor in the lamp assembly may have failed.
  - Unplug the connector to the UV Lamp Heater/Thermistor PCB, and measure the resistance of the thermistor between pins 5 and 6 of the 6-pin connector.
  - The resistance near the 58°C set point is ~8.1k ohms.

11.4.11.4. Ozone Generator Temperature

There are three possible causes for the Ozone Generator temperature to have failed.

- The O_3 generator heater has failed. Check the resistance between pins 5 and 6 on the 6-pin connector adjacent to the UV Lamp on the O3 Generator. It should be approximately 5 Ohms.
- Assuming that the I^2C bus is working and that there is no other failure with the Relay board, the FET Driver on the Relay Board may have failed. Using the **O3_GEN_HEATER** parameter under the **SIGNAL I/O** function of the **DIAG** menu, as described above, turn on and off the UV Lamp Heater. Check the DC voltage present between pin 1 and 2 on J14 of the Relay Board.

  If the FET Driver has failed, there should be no change in the voltage across pins 1 and 2.
- If the FET Driver checks out OK, the thermistor temperature sensor in the lamp assembly may have failed. Unplug the connector to the Ozone Generator Heater/Thermistor PCB, and measure the resistance of the thermistor between pins 5 and 6 of the 6-pin connector.

11.5. TROUBLESHOOTING THE O_3 PHOTOMETER

11.5.1. DYNAMIC PROBLEMS WITH THE O_3 PHOTOMETER

Dynamic problems are problems, which only manifest themselves when the photometer is measuring O_3 concentration gas mixtures. These can be the most difficult and time consuming to isolate and resolve.

Since many photometer behaviors that appear to be a dynamic in nature are often a symptom of a seemingly unrelated static problems, it is recommended that dynamic problems not be addressed until all static problems, warning conditions and subsystems have been checked and any problems found are resolved.

Once this has been accomplished, the following most common dynamic problems should be checked.

11.5.1.1. Noisy or Unstable O_3 Readings at Zero

- Check for leaks in the pneumatic system as described in Section 10.2
- Confirm that the Zero gas is free of Ozone.
- Confirm that the Source Lamp is fully inserted and that the lamp hold-down thumb- screw is tight.
- Check for a dirty Absorption Cell and/or pneumatic lines. Clean as necessary as described in Section 10.2
- Disconnect the exhaust line from the optical bench (the pneumatic line at the lamp end of the bench) and plug the port in the bench. If readings remain noisy, the problem is in one of the electronic sections of the instrument. If readings become quiet, the problem is in the instrument's pneumatics.

11.5.1.2. Noisy, Unstable, or Non-Linear Span O_3 Readings

- Check for leaks in the pneumatic systems as described in Section10.2.
- Check for proper operation of the meas/ref switching valve as described in Section11.5.2.
- Check for dirty absorption cell and clean or replace as necessary as described in Section 10.2
- Check for operation of the A/D circuitry on the motherboard. See Section 11.4.8.1.
- Confirm the Sample Temperature, Sample Pressure and Sample Flow readings are correct. Check and adjust as required.

11.5.1.3. Slow Response to Changes in Concentration

- Check for dirty absorption cell and clean or replace as necessary as described in Section 10.2
- Check for pneumatic leaks as described in Section 10.2
- Check for improper materials in the inlet manifold.
- The photometer needs 800 cc^3/min of gas flow. Make sure that this is accounted for when calculating total required output flow for the calibrator (see Section 3.4.7).

11.5.1.4. The Analog Output Signal Level Does Not Agree With Front Panel Readings

- Confirm that the recorder offset (see Section 6.9.1.5) is set to zero.
- Perform an AIO calibration (see Section 6.9.2) and photometer dark calibration (see Section 8.1.4).

11.5.1.5. Cannot Zero

- Check for leaks in the pneumatic system as described in Section 10.2.
- Confirm that the Zero gas is free of Ozone.
- The photometer needs 800 cc^3/min of gas flow. Make sure that this is accounted for when calculating total required output flow for the calibrator (see Section 3.4.7).

11.5.1.6. Cannot Span

- Check for leaks in the pneumatic systems as described in Section 10.2.
- Check for proper operation of the meas/ref switching valve as described in Section11.5.2.
- Check for dirty absorption cell and clean or replace as necessary as described in Section 10.2
- Check for operation of the A/D circuitry on the motherboard. See Section 11.4.8.1.
- Confirm the Sample Temperature, Sample Pressure and Sample Flow readings are correct. Check and adjust as required.
- The photometer needs 800 cc^3/min of gas flow. Make sure that this is accounted for when calculating total required output flow for the calibrator (see Section 3.4.7).

11.5.2. CHECKING MEASURE / REFERENCE VALVE

To check the function of the photometer's measure / reference valve:

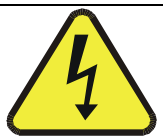
1. Set the calibrator's front panel display to show the **PHOTO REFERENCE** test function (see Section 6.1).
2. Follow the instruction in Sections 8.1.1 and 8.1.3.1 for performing a zero point calibration of the photometer.
   - Press **XZRO** and allow the calibrator to stabilize.
3. Before completing the calibration by pressing the **ZERO** key, note of the displayed value.
4. Press the final Zero key, then press "**NO**" when asked, "**ARE YOU SURE**".
5. Follow the instruction in Section 8.1.3.2 for performing a span point calibration of the photometer.
   - Press **XSPN** and allow the calibrator to stabilize.
6. Before completing the calibration by pressing the **SPAN** key, note of the displayed value of **PHOTO REF**.
   - If the O_3 REF value has decreased by more than 2 mV from its value with Zero-gas, then there is a "cross-port" leak in the m/r valve.
7. Press the final Zero key then press "**NO**" when asked, "**ARE YOU SURE**".

11.6. TROUBLESHOOTING THE O_3 GENERATOR

11.6.1. CHECKING THE UV LAMP POWER SUPPLY

NOTE

A schematic and physical diagram of the Lamp Power Supply can be found in Appendix D.



WARNING
Hazardous voltage present - use caution.

It is not always possible to determine with certainty whether a problem is the result of the UV Lamp or the Lamp Power Supply, however, the following steps will provide a reasonable confidence test of the Lamp Power Supply.

1. Unplug the cable connector at P1 on the Lamp Power Supply and confirm that +15VDC is present between Pins 1 and 2 on the cable connector.
2. If this voltage is incorrect, check the DC test points on the relay PCA as described in Section 11.4.3.
3. Remove the cover of the photometer and check for the presence of the following voltages on the UV lamp power supply PCA (see Figure 9-21):
   - +4500 mVDC ± 10 mVDC between TP1 and TP4 (grnd)
     - If this voltage is incorrect, either the UV lamp power supply PCA is faulty or the I^2C bus is not communicating with the UV lamp power supply PCA.
   - +5VDC between TP3 and TP4 (grnd)
     - If this voltages is les than 4.8 or greater than 5.25 either the 5 VDC power supply or the UV lamp power supply PCA are faulty...
   - If the above voltages check out, it is more likely that a problem is due to the UV Lamp than due to the Lamp Power Supply.
     - Replace the Lamp and if the problem persists, replace the Lamp Power Supply.

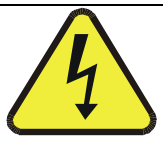
11.7. TROUBLE SHOOTING THE OPTIONAL O_3 GENERATOR

The only significant components of the O_3 generator that might reasonable malfunction is the power supply assembly for the UV source lamp and the lamp itself.

11.7.1. CHECKING THE UV SOURCE LAMP POWER SUPPLY

NOTE

A schematic and physical diagram of the Lamp Power Supply can be found in Appendix D.



WARNING
Hazardous voltage present - use caution.

It is not always possible to determine with certainty whether a problem is the result of the UV Lamp or the Lamp Power Supply, however, the following steps will provide a reasonable confidence test of the Lamp Power Supply.

1. Make sure the calibrator is in **STANDBY** mode.
2. Unplug the cable connector at P1 on the Lamp Power Supply and confirm that +15VDC is present between Pins 1 and 2 on the cable connector.
3. If this voltage is incorrect, check the DC test points on the relay PCA as described in Section 11.4.3.
4. Remove the cover of the photometer and check for the presence of the following voltages on the UV lamp power supply PCA (see Figure 9-21):
   - +800 mVDC ± 10 mVDC between TP1 and TP4 (grnd)
     - If this voltage is incorrect, either the UV lamp power supply PCA is faulty or the I^2C bus is not communicating with the UV lamp power supply PCA.
   - +5VDC between TP3 and TP4 (grnd)
     - If this voltages is less than 4.8 or greater than 5.25 either the 5 VDC power supply or the UV lamp power supply PCA are faulty.
   - If the above voltages check out, it is more likely that a problem is due to the UV Lamp than due to the Lamp Power Supply.
     - Replace the Lamp and if the problem persists, replace the Lamp Power Supply.

11.8. REPAIR PROCEDURES

11.8.1. REPAIRING SAMPLE FLOW CONTROL ASSEMBLY

The critical flow orifice is housed in the flow control assembly (Teledyne Instruments part number: 001760400) located on the top of the optical bench. A sintered filter protects the jewel orifice so it is unusual for the orifice to need replacing, but if it does, or the filter needs replacement please use the following procedure (see the Spare Parts list in Appendix B for part numbers and kits):

1. Turn off power to the calibrator.
2. Locate the assembly to be repaired, see Figure, 3–3.
3. Disconnect the pneumatic connection from the flow assembly.
4. Remove the fitting and the components as shown in the exploded view in Figure 11.6.
5. Replace the o-rings (p/n OR000001) and the sintered filter (p/n FL000001).
6. If replacing the critical flow orifice itself (P/N 000941000), make sure that the side with the colored window (usually red) is facing downstream to the gas flow.
7. Apply new Teflon® tape to the male connector threads
8. Re-assemble in reverse order.

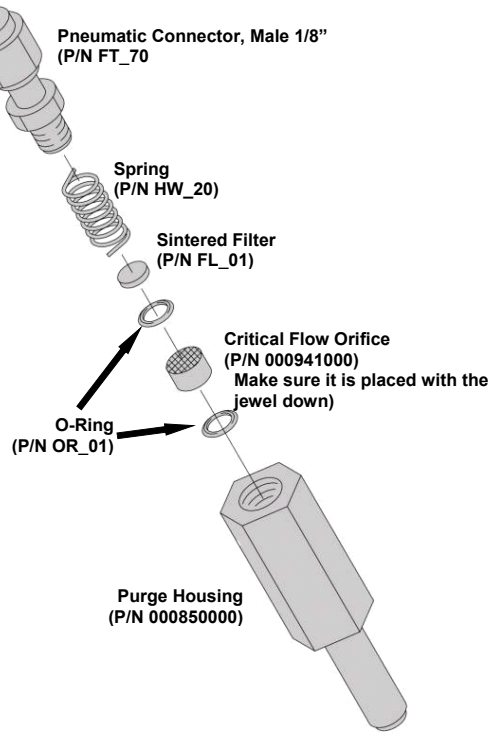


Figure 11-5: Critical Flow Restrictor Assembly Disassembly

11.8.2. DISK-ON-CHIP REPLACEMENT PROCEDURE

NOTE

Printed circuit assemblies (PCAs) are sensitive to electro-static discharges too small to be felt by the human nervous system. Failure to use ESD protection when working with electronic assemblies will void the instrument warranty.

See Chapter 12 for more information on preventing ESD damage.

Replacing the Disk-on-Chip may be necessary in certain rare circumstances or to load new instrument software. This will cause all of the instrument configuration parameters to be lost. However a backup copy of the operating parameters are stored in a second non-volatile memory and will be loaded into the new the Disk-on-Chip on power-up. To change the Disk-on-Chip, follow this procedure.

1. Turn off power to the instrument.
2. Fold down the rear panel by loosening the captive Phillips-head screws on each side
3. Locate the Disk-on-Chip in the rightmost socket near the right hand side of the CPU assembly. Remove the IC by gently prying it up from the socket.
4. Reinstall the new Disk-on-Chip, making sure the notch in the end of the chip is facing upward.
5. Close the rear panel and turn on power to the machine.

11.9. TECHNICAL ASSISTANCE

If this manual and its trouble-shooting / repair sections do not solve your problems, technical assistance may be obtained from

TELEDYNE-API, CUSTOMER SERVICE,
9480 CARROLL PARK DRIVE
SAN DIEGO, CALIFORNIA 92121-5201
USA

Toll-free Phone: 800-324-5190
Phone: 858-657-9800
Fax: 858-657-9816
Email: api-sales@teledyne.com
Website: http://www.teledyne-api.com/

Before you contact customer service, fill out the problem report form in Appendix C, which is also available online for electronic submission at http://www.teledyne-api.com/forms/.

USER NOTES:

USER NOTES:

12. A PRIMER ON ELECTRO-STATIC DISCHARGE

Teledyne Instruments considers the prevention of damage caused by the discharge of static electricity to be extremely important part of making sure that your analyzer continues to provide reliable service for a long time. This section describes how static electricity occurs, why it is so dangerous to electronic components and assemblies as well as how to prevent that damage from occurring.

12.1. HOW STATIC CHARGES ARE CREATED

Modern electronic devices such as the types used in the various electronic assemblies of your analyzer, are very small, require very little power and operate very quickly. Unfortunately, the same characteristics that allow them to do these things also make them very susceptible to damage from the discharge of static electricity. Controlling electrostatic discharge begins with understanding how electro-static charges occur in the first place.

Static electricity is the result of something called triboelectric charging which happens whenever the atoms of the surface layers of two materials rub against each other. As the atoms of the two surfaces move together and separate, some electrons from one surface are retained by the other.

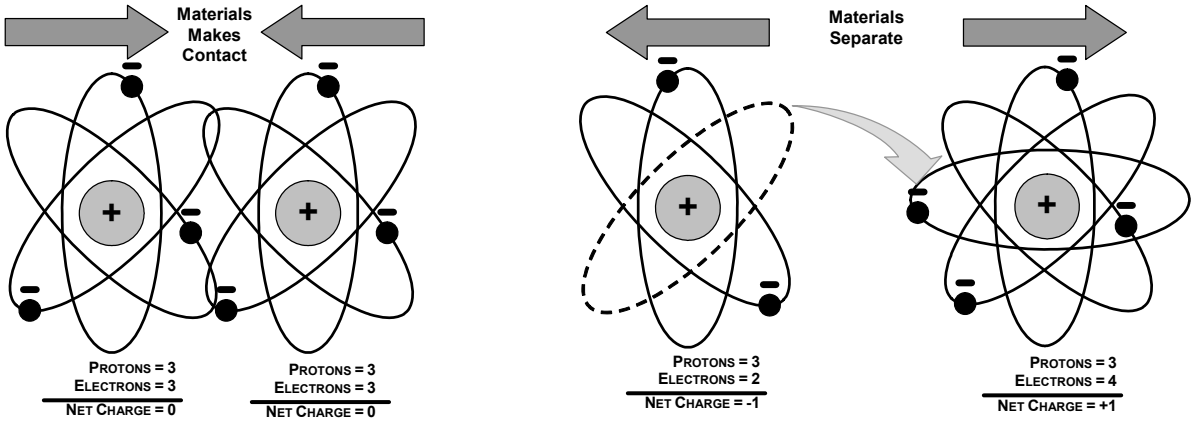


Figure 12-1: Triboelectric Charging

If one of the surfaces is a poor conductor or even a good conductor that is not grounded, the resulting positive or negative charge cannot bleed off and becomes trapped in place, or static. The most common example of triboelectric charging happens when someone wearing leather or rubber soled shoes walks across a nylon carpet or linoleum tiled floor. With each step, electrons change places and the resulting electro-static charge builds up, quickly reaching significant levels. Pushing an epoxy printed circuit board across a workbench, using a plastic handled screwdriver or even the constant jostling of Styrofoam™ pellets during shipment can also build hefty static charges

Table 12-1: Static Generation Voltages for Typical Activities

MEANS OF GENERATION	65-90% RH	10-25% RH
Walking across nylon carpet	1,500V	35,000V
Walking across vinyl tile	250V	12,000V
Worker at bench	100V	6,000V
Poly bag picked up from bench	1,200V	20,000V
Moving around in a chair padded with urethane foam	1,500V	18,000V

12.2. HOW ELECTRO-STATIC CHARGES CAUSE DAMAGE

Damage to components occurs when these static charges come into contact with an electronic device. Current flows as the charge moves along the conductive circuitry of the device and the typically very high voltage levels of the charge overheat the delicate traces of the integrated circuits, melting them or even vaporizing parts of them. When examined by microscope the damage caused by electro-static discharge looks a lot like tiny bomb craters littered across the landscape of the component's circuitry.

A quick comparison of the values in Table 12-1 with the those shown in the Table 12-2, listing device susceptibility levels, shows why *Semiconductor Reliability News* estimates that approximately 60% of device failures are the result of damage due to electro-static discharge.

Table 12-2: Sensitivity of Electronic Devices to Damage by ESD

DEVICE	DAMAGE SUSCEPTIBILITY VOLTAGE RANGE	
	DAMAGE BEGINS OCCURRING AT	CATASTROPHIC DAMAGE AT
MOSFET	10	100
VMOS	30	1800
NMOS	60	100
GaAsFET	60	2000
EPROM	100	100
JFET	140	7000
SAW	150	500
Op-AMP	190	2500
CMOS	200	3000
Schottky Diodes	300	2500
Film Resistors	300	3000
This Film Resistors	300	7000
ECL	500	500
SCR	500	1000
Schottky TTL	500	2500

Potentially damaging electro-static discharges can occur:

- Any time a charged surface (including the human body) discharges to a device. Even simple contact of a finger to the leads of a sensitive device or assembly can allow enough discharge to cause damage. A similar discharge can occur from a charged conductive object, such as a metallic tool or fixture.
- When static charges accumulated on a sensitive device discharges from the device to another surface such as packaging materials, work surfaces, machine surfaces or other device. In some cases, charged device discharges can be the most destructive.
- A typical example of this is the simple act of installing an electronic assembly into the connector or wiring harness of the equipment in which it is to function. If the assembly is carrying a static charge, as it is connected to ground a discharge will occur.
- Whenever a sensitive device is moved into the field of an existing electro-static field, a charge may be induced on the device in effect discharging the field onto the device. If the device is then momentarily grounded while within the electrostatic field or removed from the region of the electrostatic field and grounded somewhere else, a second discharge will occur as the charge is transferred from the device to ground.

12.3. COMMON MYTHS ABOUT ESD DAMAGE

- **I didn't feel a shock so there was no electro-static discharge**: The human nervous system is not able to feel a static discharge of less than 3500 volts. Most devices are damaged by discharge levels much lower than that.
- **I didn't touch it so there was no electro-static discharge**: Electro Static charges are fields whose lines of force can extend several inches or sometimes even feet away from the surface bearing the charge.
- **It still works so there was no damage**: Sometimes the damaged caused by electro-static discharge can completely sever a circuit trace causing the device to fail immediately. More likely, the trace will be only partially occluded by the damage causing degraded performance of the device or worse, weakening the trace. This weakened circuit may seem to function fine for a short time, but even the very low voltage and current levels of the device's normal operating levels will eat away at the defect over time causing the device to fail well before its designed lifetime is reached.

  These latent failures are often the most costly since the failure of the equipment in which the damaged device is installed causes down time, lost data, lost productivity, as well as possible failure and damage to other pieces of equipment or property.
- **Static Charges can't build up on a conductive surface**: There are two errors in this statement.

  Conductive devices can build static charges if they are not grounded. The charge will be equalized across the entire device, but without access to earth ground, they are still trapped and can still build to high enough levels to cause damage when discharged.

  A charge can be induced onto the conductive surface and/or discharge triggered in the presence of a charged field such as a large static charge clinging to the surface of a nylon jacket of someone walking up to a workbench.
- **As long as my analyzer is properly installed, it is safe from damage caused by static discharges**: It is true that when properly installed the chassis ground of your analyzer is tied to earth ground and its electronic components are prevented from building static electric charges themselves. This does not prevent discharges from static fields built up on other things, like you and your clothing, from discharging through the instrument and damaging it.
-

12.4. BASIC PRINCIPLES OF STATIC CONTROL

It is impossible to stop the creation of instantaneous static electric charges. It is not, however difficult to prevent those charges from building to dangerous levels or prevent damage due to electro-static discharge from occurring.

12.4.1. GENERAL RULES

Only handle or work on all electronic assemblies at a properly set up ESD station. Setting up an ESD safe workstation need not be complicated. A protective mat properly tied to ground and a wrist strap are all that is needed to create a basic anti-ESD workstation.

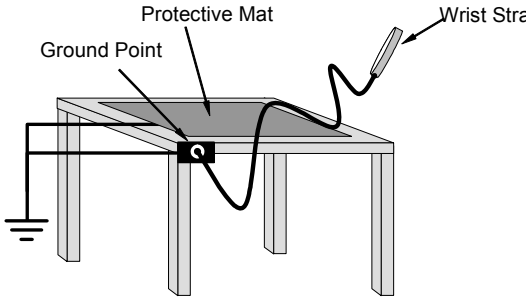


Figure 12-2: Basic anti-ESD Work Station

For technicians that work in the field, special lightweight and portable anti-ESD kits are available from most suppliers of ESD protection gear. These include everything needed to create a temporary anti-ESD work area anywhere.

- **Always wear an Anti-ESD wrist strap when working on the electronic assemblies of your analyzer**. An anti-ESD wrist strap keeps the person wearing it at or near the same potential as other grounded objects in the work area and allows static charges to dissipate before they can build to dangerous levels. Anti-ESD wrist straps terminated with alligator clips are available for use in work areas where there is no available grounded plug.

  Also, anti-ESD wrist straps include a current limiting resistor (usually around one meg-ohm) that protects you should you accidentally short yourself to the instrument's power supply.

- **Simply touching a grounded piece of metal is insufficient**. While this may temporarily bleed off static charges present at the time, once you stop touching the grounded metal new static charges will immediately begin to re-build. In some conditions, a charge large enough to damage a component can rebuild in just a few seconds.

- **Always store sensitive components and assemblies in anti-ESD storage bags or bins:** Even when you are not working on them, store all devices and assemblies in a closed anti-Static bag or bin. This will prevent induced charges from building up on the device or assembly and nearby static fields from discharging through it.

- **Use metallic anti-ESD bags for storing and shipping ESD sensitive components and assemblies rather than pink-poly bags.** The famous, pink-poly bags are made of a plastic that is impregnated with a liquid (similar to liquid laundry detergent) which very slowly sweats onto the surface of the plastic creating a slightly conductive layer over the surface of the bag.

  While this layer may equalizes any charges that occur across the whole bag, it does not prevent the build up of static charges. If laying on a conductive, grounded surface, these bags will allow charges to bleed away but the very charges that build up on the surface of the bag itself can be transferred through the bag by induction onto the circuits of your ESD sensitive device. Also, the liquid impregnating the plastic is eventually used up after which the bag is as useless for preventing damage from ESD as any ordinary plastic bag.

  Anti-Static bags made of plastic impregnated with metal (usually silvery in color) provide all of the charge equalizing abilities of the pink-poly bags but also, when properly sealed, create a Faraday cage that completely isolates the contents from discharges and the inductive transfer of static charges.

  Storage bins made of plastic impregnated with carbon (usually black in color) are also excellent at dissipating static charges and isolating their contents from field effects and discharges.

- **Never use ordinary plastic adhesive tape near an ESD sensitive device or to close an anti-ESD bag.** The act of pulling a piece of standard plastic adhesive tape, such as Scotch® tape, from its roll will generate a static charge of several thousand or even tens of thousands of volts on the tape itself and an associated field effect that can discharge through or be induced upon items up to a foot away.

12.4.2. BASIC ANTI-ESD PROCEDURES FOR ANALYZER REPAIR AND MAINTENANCE

12.4.2.1. Working at the Instrument Rack

When working on the analyzer while it is in the instrument rack and plugged into a properly grounded power supply

1. Attach you anti-ESD wrist strap to ground before doing anything else.
   - Use a wrist strap terminated with an alligator clip and attach it to any bare metal portion of the instrument chassis.
   - This will safely connect you to the same ground level to which the instrument and all of its components are connected.
2. Pause for a second or two to allow any static charges to bleed away.
3. Open the casing of the analyzer and begin work. Up to this point, the closed metal casing of your analyzer has isolated the components and assemblies inside from any conducted or induced static charges.
4. If you must remove a component from the instrument, do not lay it down on a non-ESD preventative surface where static charges may lie in wait.
5. Only disconnect your wrist strap after you have finished work and closed the case of the analyzer.

12.4.2.2. Working at an Anti-ESD Work Bench.

When working on an instrument of an electronic assembly while it is resting on a anti-ESD work bench

1. Plug you anti-ESD wrist strap into the grounded receptacle of the work station before touching any items on the work station and while standing at least a foot or so away. This will allow any charges you are carrying to bleed away through the ground connection of the workstation and prevent discharges due to field effects and induction from occurring.
2. Pause for a second or two to allow any static charges to bleed away.
3. Only open any anti-ESD storage bins or bags containing sensitive devices or assemblies after you have plugged your wrist strap into the workstation.
   - Lay the bag or bin on the workbench surface.
   - Before opening the container, wait several seconds for any static charges on the outside surface of the container to be bled away by the workstation's grounded protective mat.
4. Do not pick up tools that may be carrying static charges while also touching or holding an ESD Sensitive Device.
   - Only lay tools or ESD-sensitive devices and assemblies on the conductive surface of your workstation. Never lay them down on any non-ESD preventative surface.
5. Place any static sensitive devices or assemblies in anti-static storage bags or bins and close the bag or bin before unplugging your wrist strap.
6. Disconnecting your wrist strap is always the last action taken before leaving the workbench.

12.4.2.3. Transferring Components from Rack to Bench and Back

When transferring a sensitive device from an installed Teledyne Instruments analyzer to an Anti-ESD workbench or back:

1. Follow the instructions listed above for working at the instrument rack and workstation.
2. Never carry the component or assembly without placing it in an anti-ESD bag or bin.
3. Before using the bag or container allow any surface charges on it to dissipate:
   - If you are at the instrument rack, hold the bag in one hand while your wrist strap is connected to a ground point.
   - If you are at an anti-ESD workbench, lay the container down on the conductive work surface.
   - In either case wait several seconds.
4. Place the item in the container.
5. Seal the container. If using a bag, fold the end over and fastening it with anti-ESD tape.
   - Folding the open end over isolates the component(s) inside from the effects of static fields.
   - Leaving the bag open or simply stapling it shut without folding it closed prevents the bag from forming a complete protective envelope around the device.
6. Once you have arrived at your destination, allow any surface charges that may have built up on the bag or bin during travel to dissipate:
   - Connect your wrist strap to ground.
   - If you are at the instrument rack, hold the bag in one hand while your wrist strap is connected to a ground point.
   - If you are at a anti-ESD work bench, lay the container down on the conductive work surface
   - In either case wait several seconds
7. Open the container.

12.4.2.4. Opening Shipments from Teledyne Instruments Customer Service.

Packing materials such as bubble pack and Styrofoam pellets are extremely efficient generators of static electric charges. To prevent damage from ESD, Teledyne Instruments ships all electronic components and assemblies in properly sealed ant-ESD containers.

Static charges will build up on the outer surface of the anti-ESD container during shipping as the packing materials vibrate and rub against each other. To prevent these static charges from damaging the components or assemblies being shipped make sure that you:

Always unpack shipments from Teledyne Instruments Customer Service by:

1. Opening the outer shipping box away from the anti-ESD work area
2. Carry the still sealed ant-ESD bag, tube or bin to the anti-ESD work area
3. Follow steps 6 and 7 of Section 12.4.2.3 above when opening the anti-ESD container at the work station
4. Reserve the anti-ESD container or bag to use when packing electronic components or assemblies to be returned to Teledyne Instruments

12.4.2.5. Packing Components for Return to Teledyne Instruments Customer Service.

Always pack electronic components and assemblies to be sent to Teledyne Instruments Customer Service in anti-ESD bins, tubes or bags.

WARNING

- **DO NOT use pink-poly bags.**
- **NEVER allow any standard plastic packaging materials to touch the electronic component/assembly directly**
  - **This includes, but is not limited to, plastic bubble-pack, Styrofoam peanuts, open cell foam, closed cell foam, and adhesive tape**
- **DO NOT use standard adhesive tape as a sealer. Use ONLY anti-ESD tape**

1. Never carry the component or assembly without placing it in an anti-ESD bag or bin.
2. Before using the bag or container allow any surface charges on it to dissipate:
   - If you are at the instrument rack, hold the bag in one hand while your wrist strap is connected to a ground point.
   - If you are at an anti-ESD workbench, lay the container down on the conductive work surface.
   - In either case wait several seconds.
3. Place the item in the container.
4. Seal the container. If using a bag, fold the end over and fastening it with anti-ESD tape.
   - Folding the open end over isolates the component(s) inside from the effects of static fields.
   - Leaving the bag open or simply stapling it shut without folding it closed prevents the bag from forming a complete protective envelope around the device.

NOTE

If you do not already have an adequate supply of anti-ESD bags or containers available, Teledyne Instruments' Customer Service department will supply them (see Section 11.9 for contact information).

Follow the instructions listed above for working at the instrument rack and workstation.

USER NOTES:

USER NOTES:

APPENDIX A – Version Specific Software Documentation

APPENDIX A-1: Model 703E Software Menu Trees, Software Version C.0

APPENDIX A-2: Model 703E Setup Variables Available Via Serial I/O, Software Version C.0

APPENDIX A-3: Model 703E Warnings and Test Measurements Via Serial I/O, Software Version C.0

APPENDIX A-4: Model 703E Signal I/O Definitions, Software Version C.0

APPENDIX A-5: Model M703E Terminal Command Designators, Software Version C.0

USER NOTES:

APPENDIX A-1: Software Menu Trees, Software Version C.0

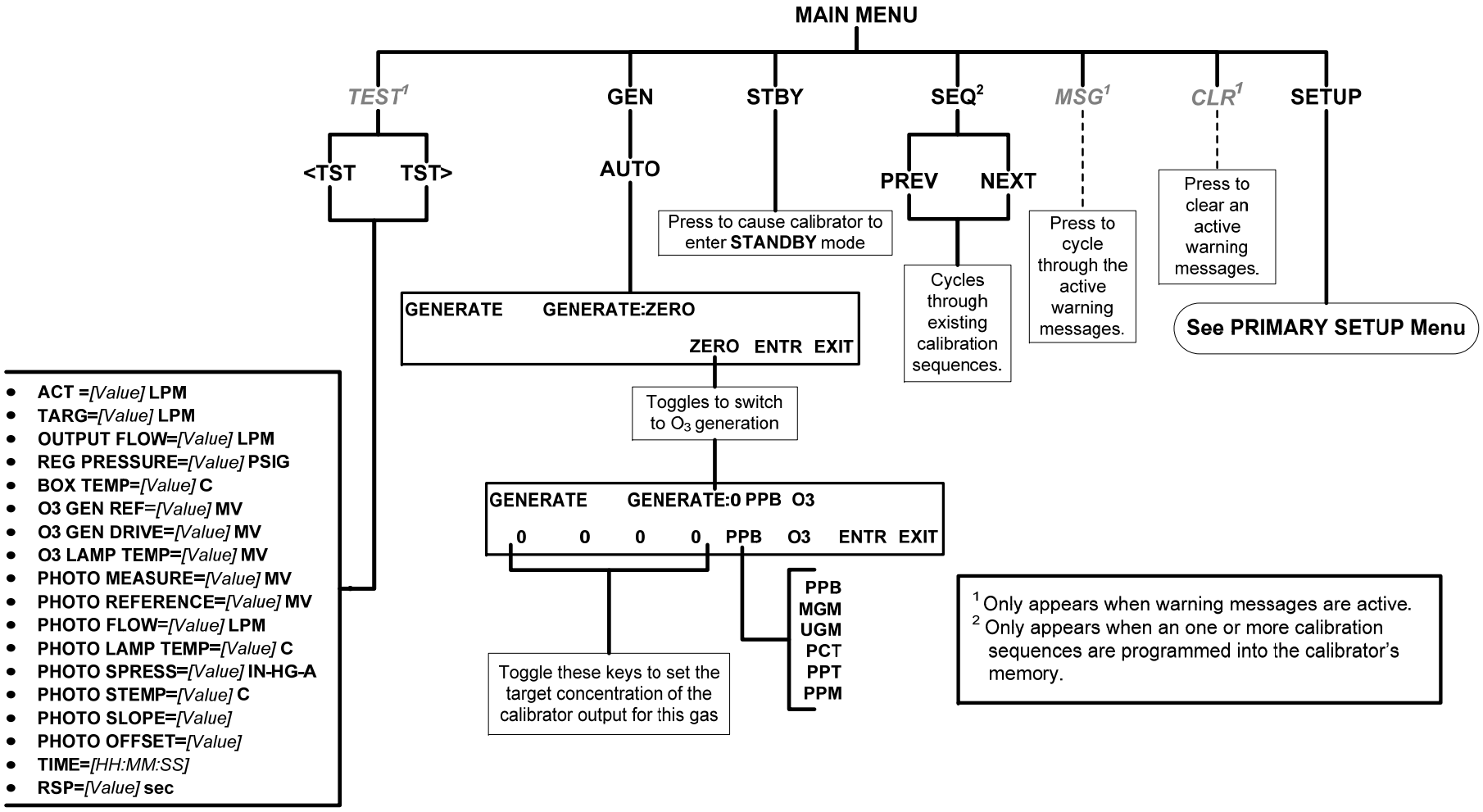


Figure A-1: Main Menu

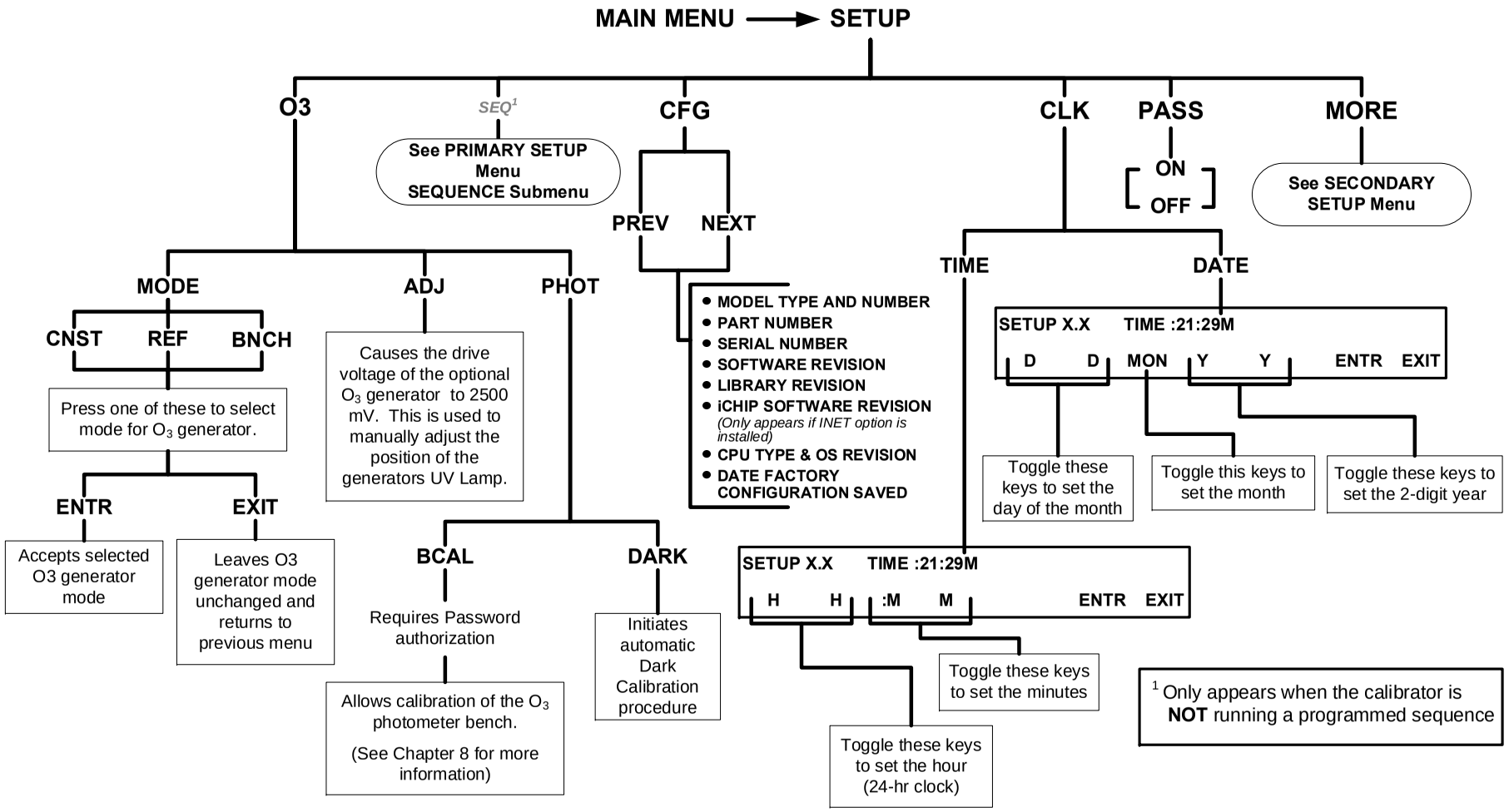

MAIN MENU → SETUP
O3
SEQ[1]
CFG
CLK
PASS
MORE
See PRIMARY SETUP Menu SEQUENCE Submenu
ON
OFF
See SECONDARY SETUP Menu
PREV
NEXT
MODE
ADJ
PHOT
TIME
DATE
CNST
REF
BNCH
MODEL TYPE AND NUMBER
PART NUMBER
SERIAL NUMBER
SOFTWARE REVISION
LIBRARY REVISION
iCHIP SOFTWARE REVISION
(Only appears if INET option is installed)
CPU TYPE & OS REVISION
DATE FACTORY CONFIGURATION SAVED
SETUP X.X TIME :21:29M
D D MON Y Y ENTR EXIT
Press one of these to select mode for O3 generator.
Causes the drive voltage of the optional O3 generator to 2500 mV. This is used to manually adjust the position of the generators UV Lamp.
Toggle these keys to set the day of the month
Toggle this keys to set the month
Toggle these keys to set the 2-digit year
ENTR
EXIT
BCAL
DARK
SETUP X.X TIME :21:29M
H H :M M ENTR EXIT
Accepts selected O3 generator mode
Leaves O3 generator mode unchanged and returns to previous menu
Requires Password authorization
Initiates automatic Dark Calibration procedure
Toggle these keys to set the minutes
Allows calibration of the O3 photometer bench.
(See Chapter 8 for more information)
Toggle these keys to set the hour (24-hr clock)
[1] Only appears when the calibrator is NOT running a programmed sequence

Figure A-2: PRIMARY SETUP MENU - Basics

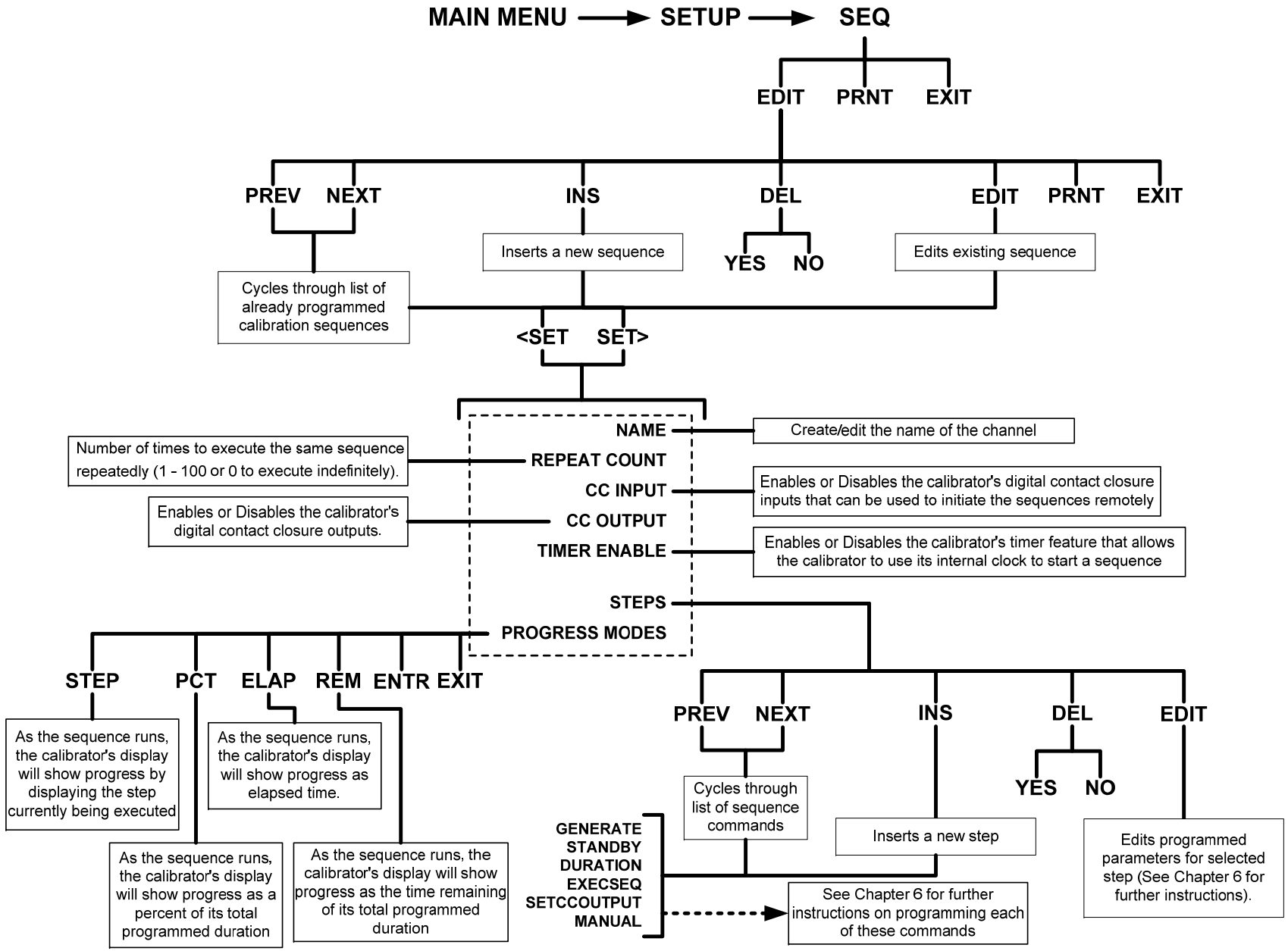

MAIN MENU
SETUP
SEQ
EDIT
PRNT
EXIT
PREV
NEXT
INS
DEL
EDIT
PRNT
EXIT
Cycles through list of already programmed calibration sequences
Inserts a new sequence
YES
NO
Edits existing sequence
<SET
SET>
NAME
Create/edit the name of the channel
Number of times to execute the same sequence repeatedly (1 - 100 or 0 to execute indefinitely).
REPEAT COUNT
CC INPUT
Enables or Disables the calibrator's digital contact closure inputs that can be used to initiate the sequences remotely
Enables or Disables the calibrator's digital contact closure outputs.
CC OUTPUT
TIMER ENABLE
Enables or Disables the calibrator's timer feature that allows the calibrator to use its internal clock to start a sequence
STEPS
PROGRESS MODES
STEP
PCT
ELAP
REM
ENTR
EXIT
As the sequence runs, the calibrator's display will show progress by displaying the step currently being executed
As the sequence runs, the calibrator's display will show progress as elapsed time.
As the sequence runs, the calibrator's display will show progress as a percent of its total programmed duration
As the sequence runs, the calibrator's display will show progress as the time remaining of its total programmed duration
PREV
NEXT
INS
DEL
EDIT
Cycles through list of sequence commands
YES
NO
Inserts a new step
Edits programmed parameters for selected step (See Chapter 6 for further instructions).
GENERATE
STANDBY
DURATION
EXECSEQ
SETCCOUTPUT
MANUAL
See Chapter 6 for further instructions on programming each of these commands

Figure A-3: PRIMARY SETUP Menu - SEQUENCE CONFIGURATION Submenu

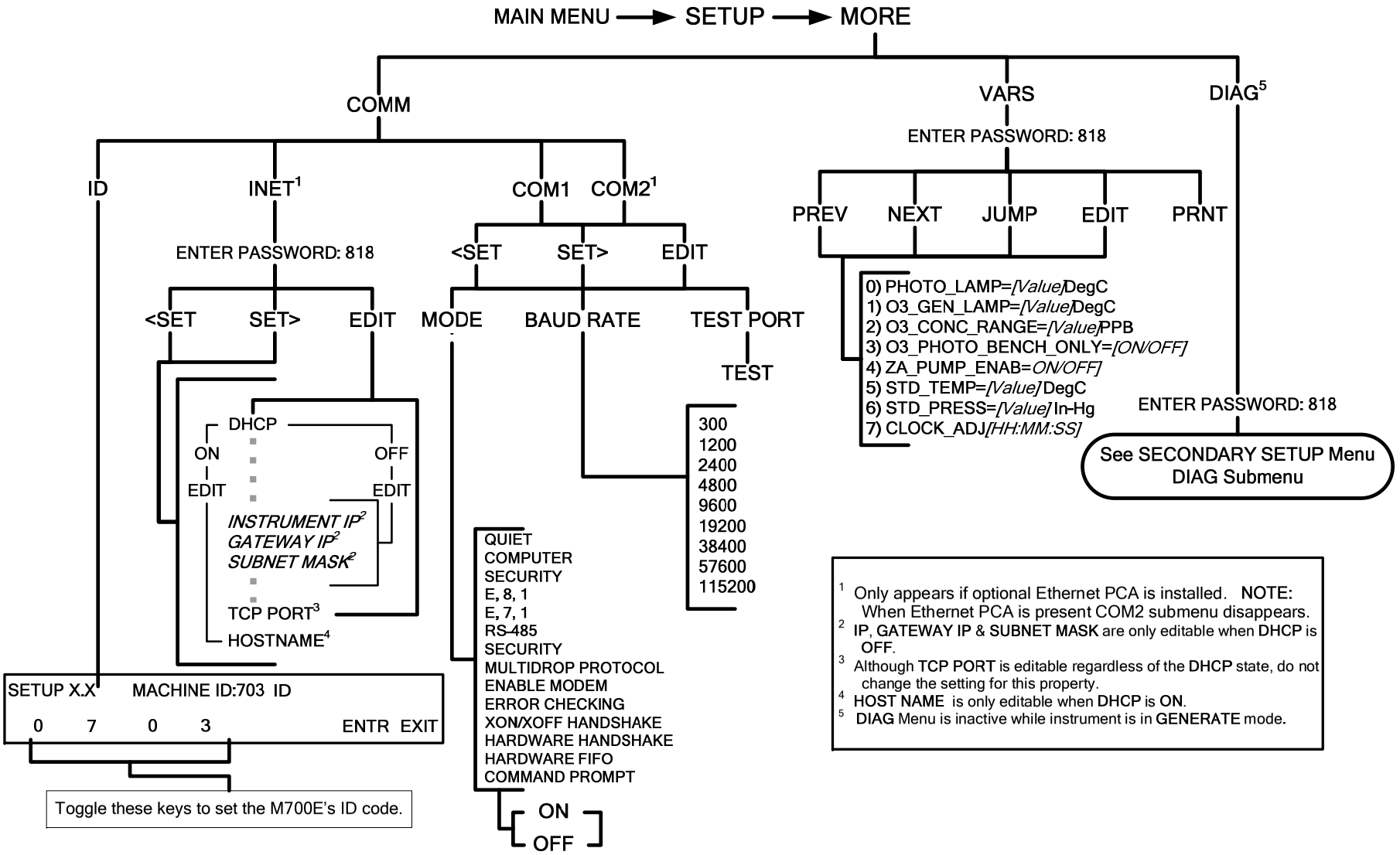


Figure A-4: SECONDARY SETUP Menu - Basic)

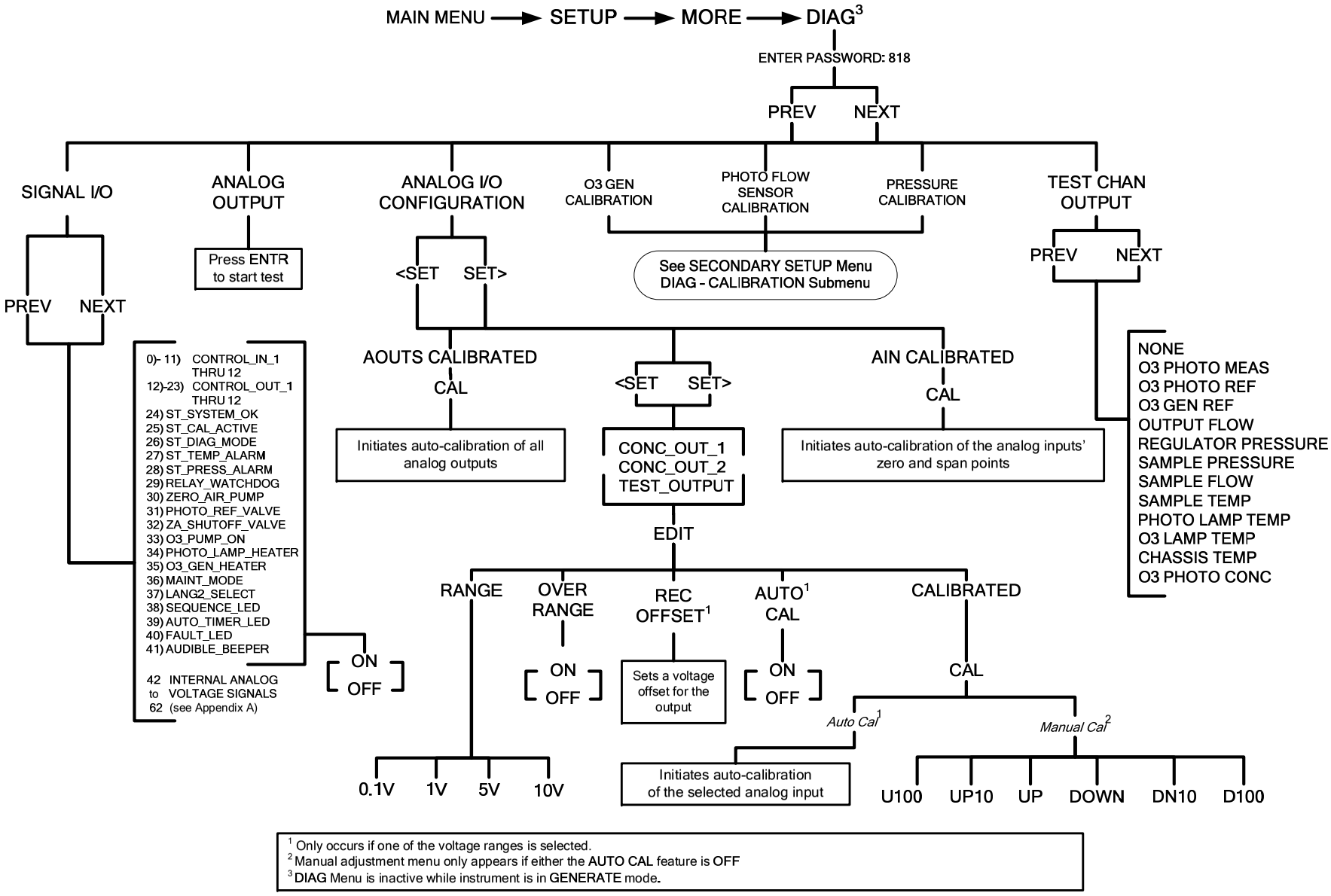


Figure A-5: SECONDARY SETUP Menu; DIAG Submenu – Basics

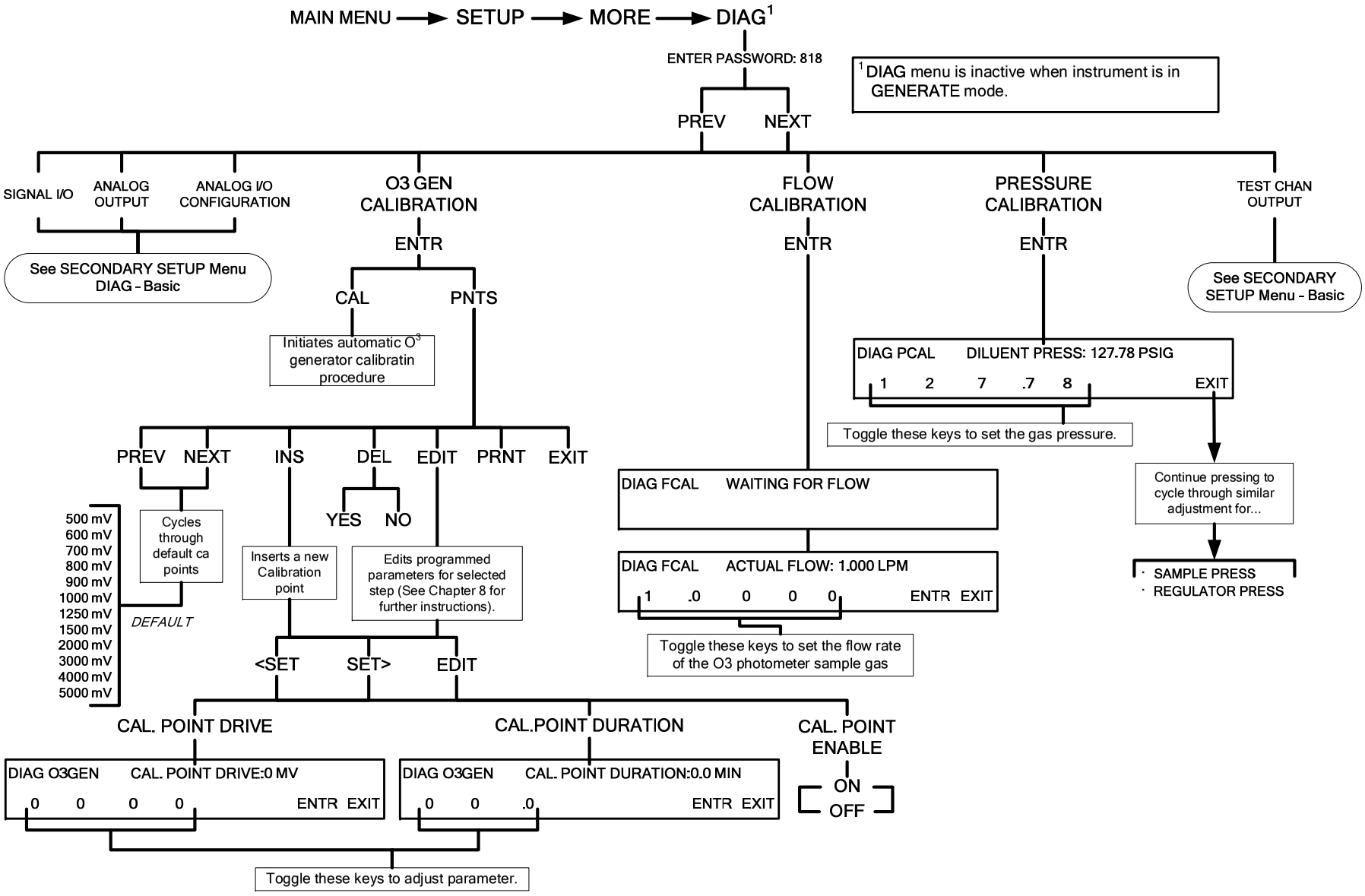

MAIN MENU → SETUP → MORE → DIAG[1]
ENTER PASSWORD: 818
[1] DIAG menu is inactive when instrument is in GENERATE mode.
PREV NEXT
SIGNAL I/O
ANALOG OUTPUT
ANALOG I/O CONFIGURATION
See SECONDARY SETUP Menu DIAG - Basic
O3 GEN CALIBRATION
ENTR
CAL PNTS
Initiates automatic O3 generator calibratin procedure
PREV NEXT INS DEL EDIT PRNT EXIT
500 mV
600 mV
700 mV
800 mV
900 mV
1000 mV
1250 mV
1500 mV
2000 mV
3000 mV
4000 mV
5000 mV
DEFAULT
Cycles through default ca points
Inserts a new Calibration point
YES NO
Edits programmed parameters for selected step (See Chapter 8 for further instructions).
<SET SET> EDIT
CAL. POINT DRIVE
DIAG O3GEN CAL. POINT DRIVE:0 MV
0 0 0 0 ENTR EXIT
CAL.POINT DURATION
DIAG O3GEN CAL. POINT DURATION:0.0 MIN
0 0 .0 ENTR EXIT
CAL. POINT ENABLE
ON
OFF
Toggle these keys to adjust parameter.
FLOW CALIBRATION
ENTR
DIAG FCAL WAITING FOR FLOW
DIAG FCAL ACTUAL FLOW: 1.000 LPM
1 .0 0 0 0 ENTR EXIT
Toggle these keys to set the flow rate of the O3 photometer sample gas
PRESSURE CALIBRATION
ENTR
DIAG PCAL DILUENT PRESS: 127.78 PSIG
1 2 7 .7 8 EXIT
Toggle these keys to set the gas pressure.
TEST CHAN OUTPUT
See SECONDARY SETUP Menu - Basic
Continue pressing to cycle through similar adjustment for...
· SAMPLE PRESS
· REGULATOR PRESS

Figure A-6: SECONDARY SETUP Menu; DIAG Submenu – GAS CONFIGURATION

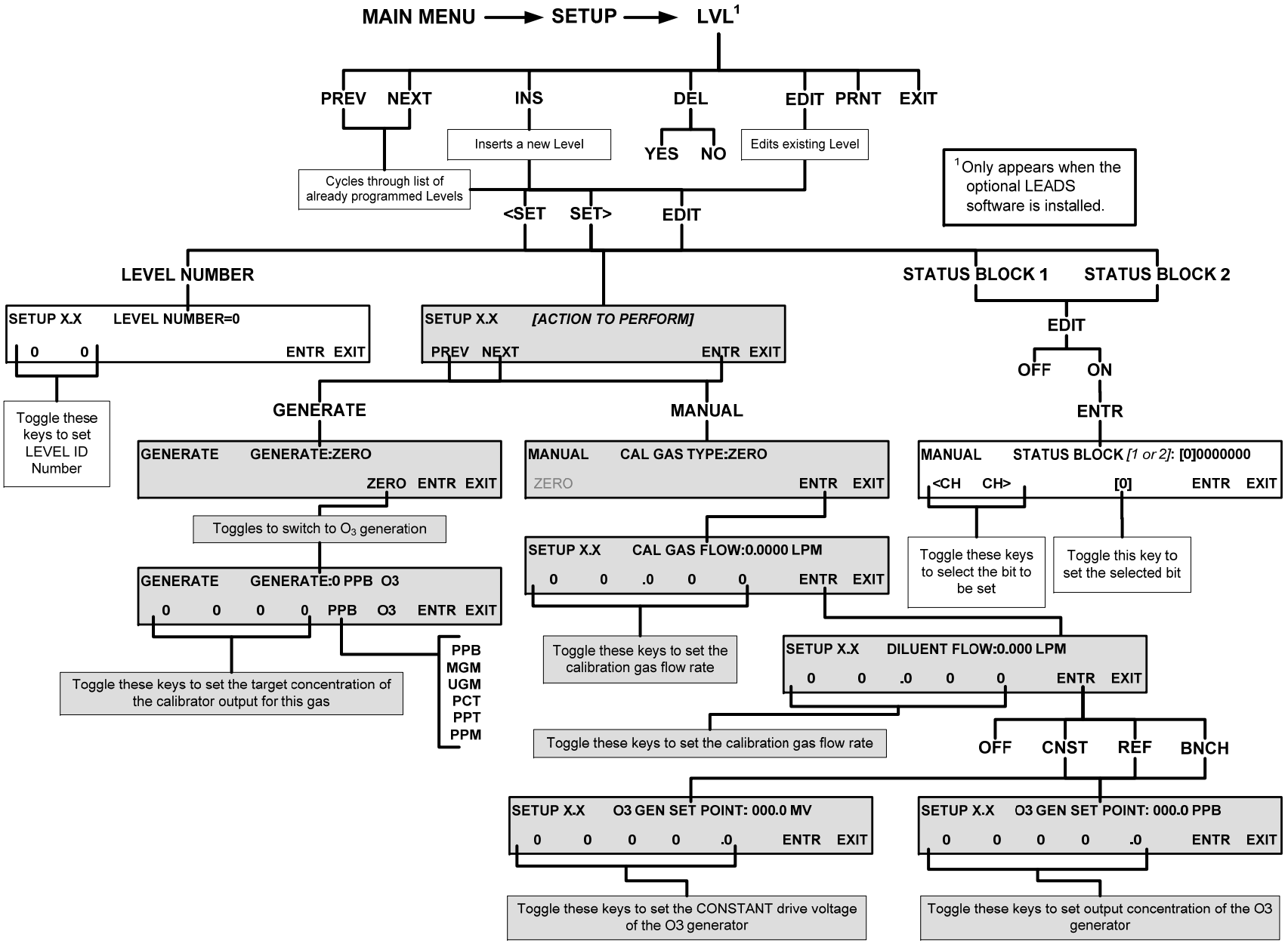

MAIN MENU → SETUP → LVL[1]
PREV NEXT
INS
DEL
EDIT PRNT EXIT
Inserts a new Level
YES NO
Edits existing Level
Cycles through list of already programmed Levels
<SET SET> EDIT
[1]Only appears when the optional LEADS software is installed.
LEVEL NUMBER
STATUS BLOCK 1 STATUS BLOCK 2
SETUP X.X LEVEL NUMBER=0
0 0 ENTR EXIT
Toggle these keys to set LEVEL ID Number
SETUP X.X [ACTION TO PERFORM]
PREV NEXT ENTR EXIT
EDIT
OFF ON
ENTR
GENERATE
MANUAL
GENERATE GENERATE:ZERO
ZERO ENTR EXIT
Toggles to switch to O3 generation
GENERATE GENERATE:0 PPB O3
0 0 0 0 PPB O3 ENTR EXIT
PPB
MGM
UGM
PCT
PPT
PPM
Toggle these keys to set the target concentration of the calibrator output for this gas
MANUAL CAL GAS TYPE:ZERO
ZERO ENTR EXIT
SETUP X.X CAL GAS FLOW:0.0000 LPM
0 0 .0 0 0 ENTR EXIT
Toggle these keys to set the calibration gas flow rate
MANUAL STATUS BLOCK [1 or 2]: [0]0000000
<CH CH> [0] ENTR EXIT
Toggle these keys to select the bit to be set
Toggle this key to set the selected bit
SETUP X.X DILUENT FLOW:0.000 LPM
0 0 .0 0 0 ENTR EXIT
Toggle these keys to set the calibration gas flow rate
OFF CNST REF BNCH
SETUP X.X O3 GEN SET POINT: 000.0 MV
0 0 0 0 .0 ENTR EXIT
Toggle these keys to set the CONSTANT drive voltage of the O3 generator
SETUP X.X O3 GEN SET POINT: 000.0 PPB
0 0 0 0 .0 ENTR EXIT
Toggle these keys to set output concentration of the O3 generator

Figure A-7: PRIMARY SETUP Menu; LVL Submenu – programming LEADS LEVELS (optional)

USER NOTES:

APPENDIX A-2: Setup Variables For Serial I/O, Software Version C.0

Table A-1: M703E Setup Variables, Software Version C.0

M703E SETUP VARIABLES FOR LATEST REVISION				
SETUP VARIABLE	**NUMERIC UNITS**	**DEFAULT VALUE**	**VALUE RANGE**	**DESCRIPTION**
Low Access Level Setup Variables (818 password)				
PHOTO_LAMP	ºC	58 Warnings: 56–61	0–100	Photometer lamp temperature set point and warning limits.
O3_GEN_LAMP	ºC	48 Warnings: 43–53	0–100	O_3 generator lamp temperature set point and warning limits.
O3_CONC_RANGE	PPB	500	0.1–20000	O_3 concentration range for test channel analog output.
O3_PHOTO_BENCH_ONLY	—	OFF	OFF, ON	O_3 bench control flag. ON turns on pump and switches measure/reference valve only in bench generation mode.
ZA_PUMP_ENAB	—	ON	OFF, ON	Zero air pump control. ON turns on zero air pump when generating ozone.
STD_TEMP	ºC	25	0–100	Standard temperature for unit conversions.
STD_PRESS	"Hg	29.92	15–50	Standard pressure for unit conversions.
CLOCK_ADJ	Sec./Day	0	-60–60	Time-of-day clock speed adjustment.
Medium Access Level Setup Variables (929 password)				
LANGUAGE_SELECT	—	ENGL	ENGL, SECD, EXTN	Selects the language to use for the user interface. Enclose value in double quotes (") when setting from the RS-232 interface.
MAINT_TIMEOUT	Hours	2	0.1–100	Time until automatically switching out of software-controlled maintenance mode.
O3_DWELL	Seconds	2.5	0.1–30	Dwell time after switching measure/reference valve.
O3_SAMPLE	Samples	1	1–30	Number of O_3 detector readings to sample.
DARK_OFFSET	mV	0	-1000–1000	Photometer dark offset for measure and reference readings.
FILT_SIZE	Samples	32	1–100	Moving average filter size.
FILT_ASIZE	Samples	6	1–100	Moving average filter size in adaptive mode.
FILT_DELTA	PPB	20	1–1000	Absolute concentration difference to trigger adaptive filter.
FILT_PCT	Percent	5	1–100	Percent concentration difference to trigger adaptive filter.
FILT_DELAY	Seconds	60	0–60	Delay before leaving adaptive filter mode.
FILT_ADAPT	—	ON	OFF, ON	ON enables adaptive filter; OFF disables it.
PDELTA_GAIN [2]	PPB/dIn-Hg	0	-200–200	Multiplied by difference between measure and reference pressure and added to concentration.
PDELTA_CAL_DUR [2]	Minutes	5	0.1–20	Duration of pressure compensation calibration procedure.
O3_SLOPE_CONST	—	1.0	0.1–10	Constant factor to keep visible slope near 1.
O3_SLOPE	—	1	0.850–1.150	O_3 photometer slope.
O3_OFFSET	PPB	0	-1000–1000	O_3 photometer offset.
O3_BCAL_SET	PPB	400	0.1–10000	Target O_3 concentration during bench span calibration.

M703E SETUP VARIABLES FOR LATEST REVISION				
SETUP VARIABLE	**NUMERIC UNITS**	**DEFAULT VALUE**	**VALUE RANGE**	**DESCRIPTION**
O3_PUMP_STARTUP	—	ON	OFF, ON	O_3 pump startup enable. ON enables startup procedure.
O3_PUMP_MIN_FLOW	LPM	0.2	0–1	Minimum flow rate that indicates O_3 pump is on.
O3_PUMP_TIMEOUT	Seconds	30	1–180	O_3 pump startup timeout.
O3_PUMP_PULSE	Seconds	0.5	0.1–10	O_3 pump power off pulse duration.
PHOTO_CYCLE	Seconds	10	0.5–30	Photometer lamp temperature control cycle period.
PHOTO_PROP	—	0.5	0–10	Photometer lamp temperature PID proportional coefficient.
PHOTO_INTEG	—	0.05	0–10	Photometer lamp temperature PID integral coefficient.
PHOTO_DERIV	—	0.2	0–10	Photometer lamp temperature PID derivative coefficient.
PHOTO_FLOW_SLOPE	—	1	0.001–100	Slope term to correct photometer sample flow rate.
O3_DEF_DRIVE	mV	0	0–5000	O_3 generator default drive setting.
O3_GEN_MODE	—	BENCH	CNST, REF, BNCH	O_3 generator control mode. Enclose value in double quotes (") when setting from the RS-232 interface.
O3_MIN_CONC	PPB	25	0–100	O_3 generator minimum reliable concentration. Less than this is treated as zero.
REF_DELAY	Seconds	60	1–300	O_3 generator reference feedback control delay.
REF_FREQ	Seconds	1	1–60	O_3 generator reference adjustment frequency.
REF_FSIZE	Samples	4	1–10	O_3 generator reference filter size.
REF_INTEG	—	0.1	0–10	O_3 generator reference PID integral coefficient.
REF_DERIV	—	0.2	0–10	O_3 generator reference PID derivative coefficient.
BENCH_DELAY	Seconds	120	1–300	O_3 generator bench feedback control delay.
BENCH_FREQ	Seconds	10	1–60	O_3 generator bench adjustment frequency.
BENCH_FSIZE	Samples	3	1–10	O_3 generator bench filter size.
BENCH_INTEG	—	0.2	0–10	O_3 generator bench PID integral coefficient.
BENCH_DERIV	—	0.5	0–10	O_3 generator bench PID derivative coefficient.
DRIVE_STABIL	mV	10	0.1–100	O_3 generator drive stability limit to update concentration cache.
CACHE_RESOL	PPB	2	0.1–20	O_3 generator cache un-normalized concentration resolution.
O3_LAMP_CYCLE	Seconds	2	0.5–30	O_3 generator lamp temperature control cycle period.
O3_LAMP_PROP	1/DegC	0.2	0–10	O_3 generator lamp temperature PID proportional coefficient.
O3_LAMP_INTEG	Gain	0.01	0–10	O_3 generator lamp temperature PID integral coefficient.
O3_LAMP_DERIV	Gain	0.2	0–10	O_3 generator lamp temperature PID derivative coefficient.
OUTPUT_FLOW_SLOPE	—	1	0.001–100	Slope term to correct output flow rate.

M703E SETUP VARIABLES FOR LATEST REVISION				
SETUP VARIABLE	**NUMERIC UNITS**	**DEFAULT VALUE**	**VALUE RANGE**	**DESCRIPTION**
RS232_MODE	BitFlag	0	0–65535	RS-232 COM1 mode flags. Add values to combine flags. 1 = quiet mode 2 = computer mode 4 = enable security 8 = enable hardware handshaking 32 = enable multi-drop 64 = enable modem 128 = ignore RS-232 line errors 256 = disable XON / XOFF support 512 = disable hardware FIFOs 1024 = enable RS-485 mode 2048 = even parity, 7 data bits, 1 stop bit 4096 = enable command prompt 8192 = even parity, 8 data bits, 1 stop bit
BAUD_RATE	—	19200	300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	RS-232 COM1 baud rate. Enclose value in double quotes (") when setting from the RS-232 interface.
MODEM_INIT	—	"AT Y0 &D0 &H0 &I0 S0=2 &B0 &N6 &M0 E0 Q1 &W0"	Any character in the allowed character set. Up to 100 characters long.	RS-232 COM1 modem initialization string. Sent verbatim plus carriage return to modem on power up or manually.
RS232_MODE2	—	0	0–65535	RS-232 COM2 mode flags. *(Same settings as RS232_MODE.)*
BAUD_RATE2	—	19200	300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	RS-232 COM2 baud rate.
MODEM_INIT2	—	"AT Y0 &D0 &H0 &I0 S0=2 &B0 &N6 &M0 E0 Q1 &W0"	Any character in the allowed character set. Up to 100 characters long.	RS-232 COM2 modem initialization string. Sent verbatim plus carriage return to modem on power up or manually.
RS232_PASS	Password	940331	0–999999	RS-232 log on password.
LINE_DELAY [1]	ms.	0	0–1000	RS-232 inter-line transmit delay (0=disabled).
MACHINE_ID	ID	700	0–9999	Unique ID number for instrument.

M703E SETUP VARIABLES FOR LATEST REVISION				
SETUP VARIABLE	**NUMERIC UNITS**	**DEFAULT VALUE**	**VALUE RANGE**	**DESCRIPTION**
COMMAND_PROMPT	—	"Cmd> "	Any character in the allowed character set. Up to 100 characters long.	RS-232 interface command prompt. Displayed only if enabled with *RS232_MODE* variable. Enclose value in double quotes (") when setting from the RS-232 interface.
TEST_CHAN_ID	—	NONE	NONE, O3 PHOTO MEAS, O3 PHOTO REF, O3 GEN REF, OUTPUT FLOW, REGULATOR PRESSURE, SAMPLE PRESSURE, SAMPLE FLOW, SAMPLE TEMP, PHOTO LAMP TEMP, O3 LAMP TEMP, CHASSIS TEMP, O3 PHOTO CONC	Diagnostic analog output ID. Enclose value in double quotes (") when setting from the RS-232 interface.
PASS_ENABLE	—	ON	OFF, ON	ON enables passwords. OFF disables them.
DEF_CC_OUTPUT	—	"000000000 000"	Any string of exactly 12 characters consisting of the digits 0 and 1 only.	Default contact closure output pattern when not executing a sequence. Enclose value in double quotes (") when setting from the RS-232 interface.
PHOTO_LAMP_POWER	mV	4500	0–5000	Photometer lamp power setting.
LAMP_PWR_ENABLE	—	ON	OFF, ON	ON enables photometer lamp power cycling. OFF disables it.
LAMP_PWR_PERIOD	Hours	24	0.01–1000	Photometer lamp power cycling period.
LAMP_OFF_DELAY	Seconds	0.1	0.02–5	Length of time photometer lamp is turned off.
DET_VALID_DELAY	Seconds	20	1–300	Delay until valid concentration is computed.
REF_SDEV_LIMIT	mV	3	0.1–100	Photometer reference standard deviation must be below this limit to switch out of startup mode.
PATH_LENGTH	cm	41.96	0.01–99.999	Photometer detector path length.
BOX_SET	ºC	30 Warnings: 5–45	0–100	Internal box temperature set point and warning limits.
GAS_MOL_WEIGHT	MolWt	32	1–99.999	Molar mass of sample gas for computing concentrations by weight instead of volume.
SERIAL_NUMBER	—	"00000000 "	Any character in the allowed character set. Up to 100 characters long.	Unique serial number for instrument.
DISP_INTENSITY	—	HIGH	HIGH, MED, LOW, DIM	Front panel display intensity. Enclose value in double quotes (") when setting from the RS-232 interface.

M703E SETUP VARIABLES FOR LATEST REVISION				
SETUP VARIABLE	**NUMERIC UNITS**	**DEFAULT VALUE**	**VALUE RANGE**	**DESCRIPTION**
I2C_RESET_ENABLE	—	ON	OFF, ON	I^2C bus automatic reset enable.
CLOCK_FORMAT	—	"TIME=%H:%M:%S"	Any character in the allowed character set. Up to 100 characters long.	Time-of-day clock format flags. Enclose value in double quotes (") when setting from the RS-232 interface. "%a" = Abbreviated weekday name. "%b" = Abbreviated month name. "%d" = Day of month as decimal number (01 – 31). "%H" = Hour in 24-hour format (00 – 23). "%I" = Hour in 12-hour format (01 – 12). "%j" = Day of year as decimal number (001 – 366). "%m" = Month as decimal number (01 – 12). "%M" = Minute as decimal number (00 – 59). "%p" = A.M./P.M. indicator for 12-hour clock. "%S" = Second as decimal number (00 – 59). "%w" = Weekday as decimal number (0 – 6; Sunday is 0). "%y" = Year without century, as decimal number (00 – 99). "%Y" = Year with century, as decimal number. "%%" = Percent sign.
FACTORY_OPT	—	0	0–65535	Factory option flags. Add values to combine options. 1024 = enable software-controlled maintenance mode 2048 = enable Internet option [3] 4096 = enable switch-controlled maintenance mode

[1] Dasibi emulation version only.

[2] Experimental.

[3] iChip option.

APPENDIX A-3: Warnings and Test Functions, Software Version C.0

Table A-2: M703E Warning Messages, Software Version C.0

NAME [1]	MESSAGE TEXT	DESCRIPTION
WSYSRES	**SYSTEM RESET**	Instrument was power-cycled or the CPU was reset.
WDATAINIT	**DATA INITIALIZED**	Data storage was erased.
WCONFIGINIT	**CONFIG INITIALIZED**	Configuration storage was reset to factory configuration or erased.
WPHOTOLTEMP	**PHOTO LAMP TEMP WARNING**	Photometer lamp temperature outside of warning limits specified by *PHOTO_LAMP* variable.
WO3GENTEMP	**O3 GEN LAMP TEMP WARNING**	O_3 generator lamp temperature outside of warning limits specified by *O3_GEN_LAMP* variable.
WPHOTOREF	**PHOTO REFERENCE WARNING**	Photometer reference reading less than 2500 mV or greater than 4999 mV.
WLAMPSTABIL	**PHOTO LAMP STABILITY WARNING**	Photometer lamp reference step changes occur more than 25% of the time.
WO3GENREF	**O3 GEN REFERENCE WARNING**	O_3 reference detector drops below 50 mV during reference feedback O_3 generator control.
WO3PUMP	**O3 PUMP WARNING**	O3 pump failed to turn on within timeout period specified by *O3_PUMP_TIMEOUT* variable.
WBOXTEMP	**BOX TEMP WARNING**	Chassis temperature outside of warning limits specified by *BOX_SET* variable.
WREARBOARD	**REAR BOARD NOT DET**	Rear board was not detected during power up.
WRELAYBOARD	**RELAY BOARD WARN**	Firmware is unable to communicate with the relay board.
WLAMPDRIVER	**LAMP DRIVER WARN**	Firmware is unable to communicate with either the O_3 generator or photometer lamp I^2C driver chip.
WFRONTPANEL	**FRONT PANEL WARN**	Firmware is unable to communicate with the front panel.
WANALOGCAL	**ANALOG CAL WARNING**	The A/D or at least one D/A channel has not been calibrated.

[1] The name is used to request a message via the RS-232 interface, as in "T BOXTEMP".

Table A-3: M703E Test Functions, Software Version C.0

TEST FUNCTION NAME [1]	MESSAGE TEXT	DESCRIPTION
ACTCONC	ACT=GENERATE 37 PPB O3	Actual concentration being generated, computed from real-time inputs.
TARGCONC	TARG=GENERATE 100 PPB O3	Target concentration to generate.
OUTPUTFLOW	OUTPUT FLOW=7.3 LPM	Output flow rate (computed from regulator pressure).
REGPRESS	REG PRESSURE=20.1 PSIG	Regulator pressure.
BOXTEMP	BOX TEMP=31.2 C	Internal chassis temperature.
O3GENREF	O3 GEN REF=1000.0 MV	O_3 generator reference detector reading.
O3GENDRIVE	O3 GEN DRIVE=800.0 MV	O_3 generator lamp drive output.
O3GENTEMP	O3 LAMP TEMP=49.7 C	O_3 generator lamp temperature.
PHOTOMEAS	PHOTO MEASURE=2998.8 MV	Photometer detector measure reading.
PHOTOREF	PHOTO REFERENCE=3000.0 MV	Photometer detector reference reading.
PHOTOFLOW	PHOTO FLOW=0.2978 LPM	Photometer sample flow rate.
PHOTOLTEMP	PHOTO LAMP TEMP=52.6 C	Photometer lamp temperature.
PHOTOSPRESS	PHOTO SPRESS=29.9 IN-HG-A	Photometer sample pressure.
PHOTOSTEMP	PHOTO STEMP=31.8 C	Photometer sample temperature.
PHOTOSLOPE	PHOTO SLOPE=1.000	Photometer slope computed during zero/span bench calibration.
PHOTOOFFSET	PHOTO OFFSET=0.0 PPB	Photometer offset computed during zero/span bench calibration.
PHOTOSTABIL [2]	PHOTO STABIL=0.1 PPB	Photometer concentration stability (standard deviation of 25 bench concentration samples taken 10 seconds apart).
TESTCHAN	TEST=2753.9 MV	Value output to *TEST_OUTPUT* analog output, selected with *TEST_CHAN_ID* variable.
CLOCKTIME	TIME=14:48:01	Current instrument time of day clock.

[1] The name is used to request a message via the RS-232 interface, as in "T BOXTEMP".

[2] O_3 photometer stability measurement option.

USER NOTES:

APPENDIX A-4: Signal I/O Definitions, Software Version C.0

Table A-4: M703E Signal I/O Definitions, Software Version C.0

M703E I/O Signal List for Latest Revision		
Signal Name	**Bit or Channel Number**	**Description**
U11, J1004, control inputs, pins 1-6 = bits 0-5, read, default I/O address 321 hex		
CONTROL_IN_1 – CONTROL_IN_6	0–5	0 = input asserted 1 = de-asserted
	6–7	Always 1
U14, J1006, control inputs, pins 1-6 = bits 0-5, read, default I/O address 325 hex		
CONTROL_IN_7 – CONTROL_IN_12	0–5	0 = input asserted 1 = de-asserted
	6–7	Always 1
U17, J1008, control outputs, pins 1-8 = bits 0-7, write, default I/O address 321 hex		
CONTROL_OUT_1 – CONTROL_OUT_8	0–7	0 = output asserted 1 = de-asserted
U21, J1008, control outputs, pins 9-12 = bits 0-3, write, default I/O address 325 hex		
CONTROL_OUT_9 – CONTROL_OUT_12	0–3	0 = output asserted 1 = de-asserted
U7, J108, internal inputs, pins 9-16 = bits 0-7, read, default I/O address 322 hex		
	0–7	Spare
U8, J108, internal outputs, pins 1-8 = bits 0-7, write, default I/O address 322 hex		
	0–7	Spare
U24, J1017, A status outputs, pins 1-8 = bits 0-7, write, default I/O address 323 hex		
ST_SYSTEM_OK	0	0 = system OK 1 = any alarm condition or in diagnostics mode
	1	Spare
ST_CAL_ACTIVE	2	0 = executing sequence 1 = not executing sequence
ST_DIAG_MODE	3	0 = in diagnostic mode 1 = not in diagnostic mode
ST_TEMP_ALARM	4	0 = any temperature alarm 1 = all temperatures OK
ST_PRESS_ALARM	5	0 = any pressure alarm 1 = all pressures OK
	6-7	Spare
U27, J1018, B status outputs, pins 1-8 = bits 0-7, write, default I/O address 324 hex		
	0-7	Spare
Relay board digital output (PCF8575), write, default I^2C address 44 hex		
RELAY_WATCHDOG	0	Alternate between 0 and 1 at least every 5 seconds to keep relay board active
ZERO_AIR_PUMP	1	0 = pump on for zero air 1 = off
	2–5	Spare

M703E I/O Signal List for Latest Revision		
Signal Name	**Bit or Channel Number**	**Description**
PHOTO_REF_VALVE	6	0 = photometer valve in reference position 1 = measure position
ZA_SHUTOFF_VALVE	7	0 = open zero air shutoff valve 1 = close
O3_PUMP_ON	8	0 = pump on for photometer to measure O_3 1 = off
	9–13	Spare
PHOTO_LAMP_HEATER	14	0 = O_3 photometer lamp heater on 1 = off
O3_GEN_HEATER	15	0 = O_3 generator lamp heater on 1 = off
Front panel I^2C keyboard, default I^2C address 4E hex		
MAINT_MODE	5 (input)	0 = maintenance mode 1 = normal mode
LANG2_SELECT	6 (input)	0 = select second language 1 = select first language (English)
SEQUENCE_LED	8 (output)	0 = sequence LED on (executing sequence) 1 = off
AUTO_TIMER_LED	9 (output)	0 = automatic timer LED on (automatic sequence timer enabled) 1 = off
FAULT_LED	10 (output)	0 = fault LED on 1 = off
AUDIBLE_BEEPER	14 (output)	0 = beeper on (for diagnostic testing only) 1 = off
Rear board primary MUX analog inputs		
PHOTO_DET	0	Photometer detector reading
O3_GEN_REF_DET	1	O_3 generator reference detector reading
	2	Spare
PHOTO_SAMP_PRES	3	Photometer sample pressure
	4	Temperature MUX
REGULATOR_PRESS	5	Regulator pressure
PHOTO_FLOW	6	Photometer flow
	7–8	Spare
REF_4096_MV	9	4.096V reference from MAX6241
	10-11	Spare
OUTPUT_FLOW	12	Output flow
	13	Spare
	14	DAC loopback MUX
REF_GND	15	Ground reference
Rear board temperature MUX analog inputs		
BOX_TEMP	0	Internal box temperature
PHOTO_SAMP_TEMP	1	Photometer sample temperature

M703E I/O Signal List for Latest Revision		
Signal Name	**Bit or Channel Number**	**Description**
PHOTO_LAMP_TEMP	2	Photometer lamp temperature
O3_GEN_TEMP	3	O_3 generator lamp temperature
	4–7	Spare
Rear board DAC MUX analog inputs		
DAC_CHAN_1	0	DAC channel 0 loopback
DAC_CHAN_2	1	DAC channel 1 loopback
DAC_CHAN_3	2	DAC channel 2 loopback
DAC_CHAN_4	3	DAC channel 3 loopback
Rear board analog outputs		
CONC_OUT_1	0	Concentration output #1
CONC_OUT_2	1	Concentration output #2
	2	Spare
TEST_OUTPUT	3	Test measurement output
I^2C analog output (AD5321), default I^2C address 18 hex		
PHOTO_LAMP_DRIVE	0	O_3 photometer lamp drive (0–5V)
I^2C analog output (AD5321), default I^2C address 1A hex		
O3_GEN_DRIVE	0	O_3 generator lamp drive (0–5V)

APPENDIX A-5: Terminal Command Designators, Software Version C.0

Table A-5: Terminal Command Designators, Software Version C.0

COMMAND	ADDITIONAL COMMAND SYNTAX	DESCRIPTION
? [ID]		Display help screen and commands list
LOGON [ID]	password	Establish connection to instrument
LOGOFF [ID]		Terminate connection to instrument
T [ID]	SET ALL|name|hexmask	Display test(s)
	LIST [ALL|name|hexmask] [NAMES|HEX]	Print test(s) to screen
	name	Print single test
	CLEAR ALL|name|hexmask	Disable test(s)
W [ID]	SET ALL|name|hexmask	Display warning(s)
	LIST [ALL|name|hexmask] [NAMES|HEX]	Print warning(s)
	name	Clear single warning
	CLEAR ALL|name|hexmask	Clear warning(s)
C [ID]	ZERO|LOWSPAN|SPAN [1|2]	Enter calibration mode
	ASEQ number	Execute automatic sequence
	COMPUTE ZERO|SPAN	Compute new slope/offset
	EXIT	Exit calibration mode
	ABORT	Abort calibration sequence
D [ID]	LIST	Print all I/O signals
	name[=value]	Examine or set I/O signal
	LIST NAMES	Print names of all diagnostic tests
	ENTER name	Execute diagnostic test
	EXIT	Exit diagnostic test
	RESET [DATA] [CONFIG] [exitcode]	Reset instrument
V [ID]	LIST	Print setup variables
	name[=value [warn_low [warn_high]]]	Modify variable
	name="value"	Modify enumerated variable
	CONFIG	Print instrument configuration
	MAINT ON|OFF	Enter/exit maintenance mode
	MODE	Print current instrument mode

The command syntax follows the command type, separated by a space character. Strings in [brackets] are optional designators. The following key assignments also apply.

Table A-6: Terminal Key Assignments, Software Version C.0

TERMINAL KEY ASSIGNMENTS	
ESC	Abort line
CR (ENTER)	Execute command
Ctrl-C	Switch to computer mode
COMPUTER MODE KEY ASSIGNMENTS	
LF (line feed)	Execute command
Ctrl-T	Switch to terminal mode

APPENDIX B: Spare Parts List

NOTE

Use of replacement parts other than those supplied by API may result in non-compliance with European standard EN 61010-1.

- 05834 - LIST, SPARE PARTS, M703E
- 05863 - LIST, RECOMMENDED SPARES STOCKING LEVELS, M703E

THIS PAGE IS INTENTIONALLY LEFT BLANK

Spare Parts List
M703E

Part Number	Description
000940100	CD, ORIFICE, .003 GREEN
006120100	ASSY, OZONE GEN LAMP (BIR) (OP5)
022710000	ABSORPTION TUBE, QUARTZ, M400A/E (KB)
040010000	ASSY, FAN REAR PANEL, E SERIES
040030700	PCA, PRESS SENSORS (2X), 700E PHOTO OPT
040300110	ASSY, CONFIG PLUG, 100-115V, M400E/M703E
040300210	ASSY, CONFIG PLUG, 220-240V, M400E/M703E
041200000	PCA, DET PREAMP w/OP20, M400E/M700E/M703
041200200	PCA, DET PREAMP w/OP20 M700E/ M400E/M703
041440000	PCA, DC HTR/TEMP, BENCH, M400E/M70XE
042010000	ASSY, SAMPLE THERMISTOR, M400E
042580000	PCA, KEYBOARD, E-SERIES, W/V-DETECT
042900100	PROGRAMMED FLASH, E SERIES
045230100	PCA, RELAY CARD, E SERIES
046740000	ASSY, PUMP, 12VDC, M460M/M700E/M465L
049290000	CLIP, THERMISTOR HOLDER
050700500	KIT, RELAY BD M703E CONFIGURATION
052400000	ASSY, BENCH UV LAMP, (BIR), CR *
052910100	ASSY, OPTICAL BENCH, M400E/M703E
055220000	ASSY, VALVE W/CONN, VA 59
055730000	ASSY, REGULATOR, FILTERS, 20LPM M703E
056420000	ASSY, FLOW CNTRL,5LPM, DILUTION, M703E
056430000	ASSY, FLOW CONTROL, PHOTO REF, M703E
057360000	ASSY, 3/8" VENT ADAPTER, M700E
057430000	MANUAL, OPERATORS, M703E
057660000	ASSY, DFU FILTER, M703E
057670000	ASSY, CARBON SCRUBBER, M703E
058021400	PCA, E-SERIES MTHRBRD, M700E, GEN 5-I
058110000	ASSY, EXPENDABLES AKIT, M703E*
058330000	ASSY, INT PUMP, 115V, M703E
058330100	ASSY, INT PUMP, 230V, M703E
062870000	CPU, PC-104, VSX-6150E, ICOP *(KB)
063720100	DOM, w/SOFTWARE, M703E *
064130000	ASSY, DC HEATER/THERM PCA, O3 GEN
CN0000073	POWER ENTRY, 120/60 (KB)
CP0000026	CPU MOD, AR-B1320, PC/104, 38 (KB)
DS0000025	DISPLAY, E SERIES (KB)
FL0000001	FILTER, SS
FL0000003	FILTER, DFU (KB)
FL0000020	CARBON FILTER, DAU, 000 GRADE *(KB)
FM0000004	FLOWMETER (KB)
FM0000005	FLOW RESTRICTOR, 5000-1/4-10000CCM
FM0000006	FLOW RESTRICTOR, 5000-1/4-5000CCM
HW0000005	FOOT
HW0000020	SPRING

Spare Parts List
M703E

Part Number	Description
HW0000380	HANDLE, CARRYING, 9.25", BLK *
HW0000453	SUPPORT, CIRCUIT BD, 3/16" ICOP
KIT000253	ASSY & TEST, SPARE PS37, E SERIES
KIT000254	ASSY & TEST, SPARE PS38, E SERIES
KIT000289	KIT, UV LAMP P/S PCA, 041660100
KIT000290	KIT, UV LAMP P/S PCA, 041660500
OP0000014	QUARTZ DISC, .75 DIA X 1/16", M400A (KB)
OP0000031	WINDOW, QUARTZ, 1/2"DIA, .063" THICK (KB
OR0000001	ORING, 2-006VT *
OR0000016	ORING, 2-120V
OR0000026	ORING, 2-110 S604-70
OR0000034	ORING, 2-011V FT10
OR0000039	ORING, 2-012V
OR0000048	ORING, 2-112S
OR0000077	ORING, 2-018V
OR0000089	ORING, 2-016V
RL0000015	RELAY, DPDT, (KB)
SW0000051	SWITCH, POWER CIRC BREAK VDE/CE, w/RG(KB
SW0000059	PRESSURE SENSOR, 0-15 PSIA, ALL SEN
SW0000060	PRESSURE SENSOR, 0-100 PSIG, ALL SEN700e
VA0000014	REGULATOR
VA0000060	CHECK VALVE, B, 1/4" TUBE FITTINGS
WR0000008	POWER CORD, 10A

Recommended Spare Parts Stocking Levels
M703E

Recommended Spare Parts Stocking Level: Standard

Part Number	Description	Units				
		1	2-5	6-10	11-20	21-30
006120100	ASSY, OZONE GEN LAMP			1	2	4
022710000	ABSORPTION TUBE, QUARTZ		1	2	4	8
058330000	ASSY, INT PUMP, 115V/60Hz					1
058330100	ASSY, INT PUMP, 230V/50Hz					1
040010000	ASSY, FAN, REAR PANEL	1	1	2	4	8
040030700	PCA, PRESS SENSORS PHOTO OPT		1	2	4	8
041200000	PCA, DET. PREAMP w/OP20, BENCH				1	2
041200200	PCA, DET. PREAMP w/OP20, O3 GEN				1	2
041440000	PCA, DC HEATER/TEMP SENSOR	1	1	2	4	8
041660100	PCA, UV POWER SUPPLY, O3 GEN,				1	2
041660500	PCA, UV POWER SUPPLY, OPT BENCH				1	2
062870000	CPU, PC-104, VSX-6150E, ICOP *(KB)				1	2
042010000	THERMISTOR ASSEMBLY	1	1	2	4	8
042580000	KEYBOARD				1	2
045230100	PCA, RELAY CARD			1	2	4
046740000	ASSY, PUMP, 12 VDC					1
052400000	ASSY, UV LAMP BENCH			1	2	4
056420000	ASSY, FLOW CONTROL, DILUTION				1	2
056430000	ASSY, FLOW CONTROL, PHOTO REF				1	2
058021400	PCA, E-SERIES MOTHERBOARD, GEN 5-I				1	2
DS0000025	DISPLAY				1	2
KIT000253	KIT, SPARE, PS37, PWR SUPPLY,+5V,+15V,-15V				1	2
KIT000254	KIT, SPARE, PS38, POWER SUPPLY, 12V				1	2

THIS PAGE IS INTENTIONALLY LEFT BLANK

Model M703E Calibrator Operator's Manual	Warranty/Repair Questionnaire Model 703E	TELEDYNE ADVANCED POLLUTION INSTRUMENTATION A Teledyne Technologies Company

CUSTOMER:_____ PHONE: _____

CONTACT NAME: _____ FAX NO. _____

SITE ADDRESS:_____

MODEL TYPE: _____ SERIAL NO.:_____ FIRMWARE REVISION:_____

Are there any failure messages? _____

_____

_____

_____

_____ *(Continue on back if necessary)*

PLEASE COMPLETE THE FOLLOWING TABLE:

PARAMETER	RECORDED VALUE	ACCEPTABLE VALUE
ACT	PPB	1% OF TARG
TARG	PPB	50 – 1000 PPB
OUTPUT FLOW	LPM	2 – 5 LPM
REG PRESSURE	PSIG	15 ± 2 PSIG @ 5 LPM
BOX TEMP	ºC	20 – 35 ºC
O_3 GEN REF	mV	0 – 5000 mV
O_3 GEN DRIVE	mV	0 – 5000mV
O_3 LAMP TEMP	ºC	48 ± 1 ºC
PHOTO MEASURE	mV	2500 – 4700 mV
PHOTO REFERENCE	mV	2500 – 4700 mV
PHOTO FLOW	LPM	0.720 – 0.880 LPM
PHOTO LAMP TEMP	ºC	58 ± 1 ºC
PHOTO SPRESS	IN-HG-A	-1" AMBIENT IN-HG-A
PHOTO STEMP	ºC	25 – 48ºC
PHOTO SLOPE		1 ± 0.15
PHOTO OFFSET	PPB	0 ± 10 PPB

Depending on options installed, not all test parameters shown below will be available in your calibrator)
[1] If ozone generator option installed.
[2] If photometer option installed.
[3] If permeation tube installed.

What is measured photometer flow rate _____ cc^3/min

What is measured O_3 generator flow rate? _____ cc^3/min

What is the photo reference value while generating **SPAN:** _____ **ZERO**:_____

TELEDYNE API CUSTOMER SERVICE
EMAIL: api-customerservice@teledyne.com
PHONE: (858) 657-9800 TOLL FREE: (800) 324-5190 FAX: (858) 657-9816

What are the failure symptoms? _____

_____

_____

_____

What tests have you done trying to solve the problem? _____

_____

_____

_____

_____

Thank you for providing this information. Your assistance enables Teledyne Instruments to respond faster to the problem that you are encountering.

OTHER NOTES: _____

TELEDYNE API CUSTOMER SERVICE
EMAIL: api-customerservice@teledyne.com
PHONE: (858) 657-9800 TOLL FREE: (800) 324-5190 FAX: (858) 657-9816

APPENDIX D: Diagrams and Schematics

Table D-1: List of Included Diagrams and Schematics

Document #	Document Title
05826	Interconnect Drawing M703E
05827	Interconnect List M703E
04420	SCH, PCA 04120, UV DETECTOR, M400E
04422	SCH, PCA 04144, DC HEATER/TEMP SENSOR
04421	SCH, PCA 04166, UV LAMP POWER SUPPLY, M400E
04259	SCH, PCA 04258, KEYBOARD, E-SERIES
04354	SCH, PCA 04003, Pressure/Flow Transducer Interface
04395	SCH, PCA 04394, INTRFC,ETHERNET,E-SERIES
04524	SCH, PCA 04523, RELAY CARD, M100E/M200E/M400E
05703	SCH, PCA 05702, MTHERBRD, E-SER, GEN-4

THIS PAGE IS INTENTIONALLY LEFT BLANK

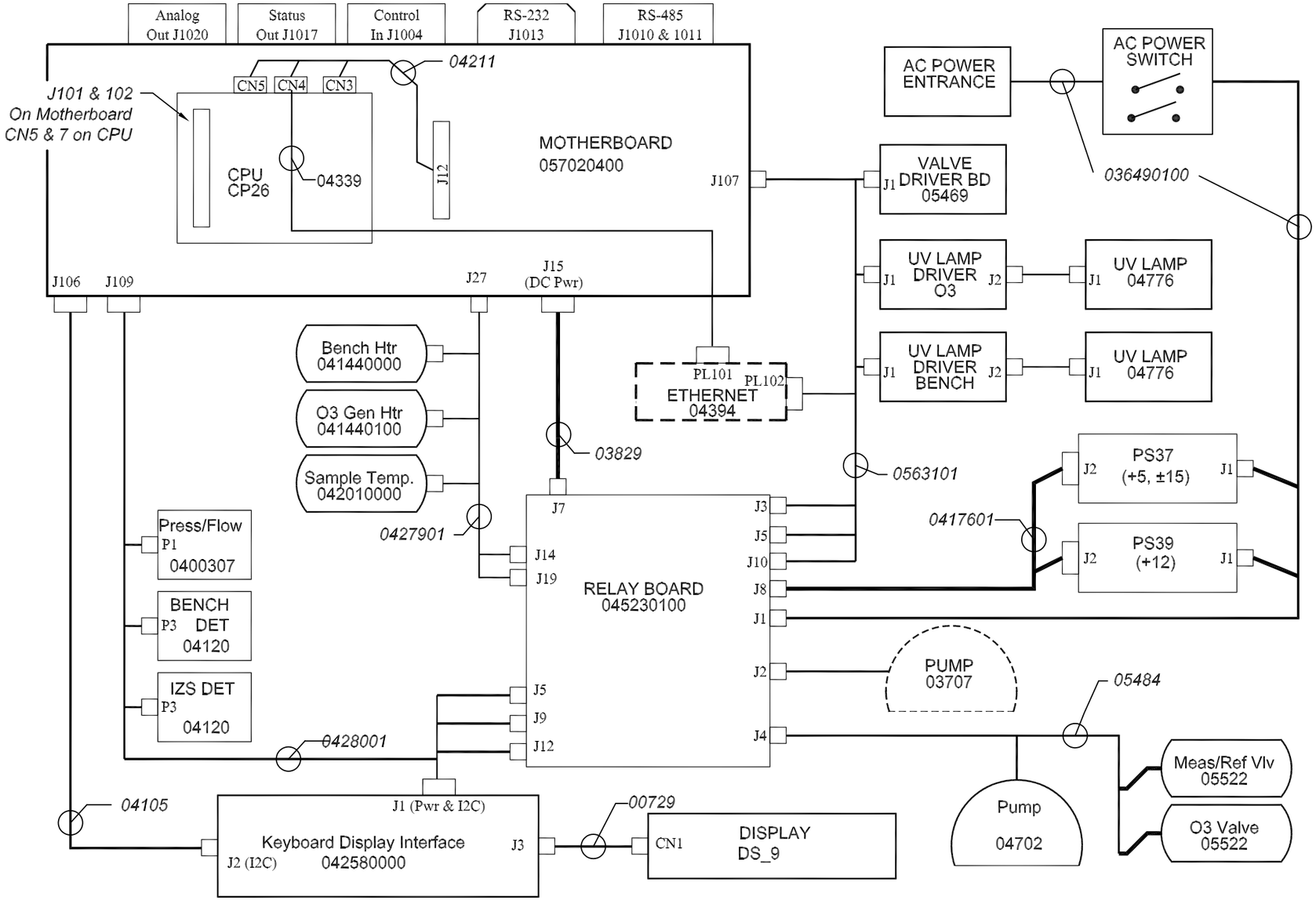
APPENDIX D: Diagrams and Schematics

Table D-1: List of Included Diagrams and Schematics

Document #	Document Title
05826	Interconnect Drawing M703E
05827	Interconnect List M703E
04420	SCH, PCA 04120, UV DETECTOR, M400E
04422	SCH, PCA 04144, DC HEATER/TEMP SENSOR
04421	SCH, PCA 04166, UV LAMP POWER SUPPLY, M400E
04259	SCH, PCA 04258, KEYBOARD, E-SERIES
04354	SCH, PCA 04003, Pressure/Flow Transducer Interface
04395	SCH, PCA 04394, INTRFC,ETHERNET,E-SERIES
04524	SCH, PCA 04523, RELAY CARD, M100E/M200E/M400E
05703	SCH, PCA 05702, MTHERBRD, E-SER, GEN-4

THIS PAGE IS INTENTIONALLY LEFT BLANK

REVISIONS				
REV	DESCRIPTION	DATE	DCN	APPROVED
A	PRODUCTION RELEASE	1/10/07	4328	KV



KEY:
1. All part numbers in *Italic* identify cables that are refered to in the accompanying document 05827.
2. All items in Dashed boxes are optional.

PRINTED DOCUMENTS ARE UNCONTROLLED

The information hereon is the property of API and is submitted in strictest confidence for reference only. Unauthoized use by anyone for any other purposes is prohibited. this document or any information contained in it may be be duplicated without proper authorization.

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ±1/32 DECIMALS ± .030 (.78) = .01(0.25) ANGULAR ±0° 30'
DO NOT SCALE DRAWING
TREATMENT: NA
FINISH:
SIMILAR TO | ACT WT. | CALC WT.

CONTRACT: NA

APPROVALS	DATE
DRAWN: KV	10/06
CHECK:	
CCB:	
ISSUED:	

TELEDYNE INSTRUMENTS — *Advanced Pollution Instrumentation* — A Teledyne Technologies Company

TITLE: INTERCONNECT DIAGRAM M703E

SIZE	CAGE CODE NO.	DWG. NO.	REV
D	1JZF4	05826	A

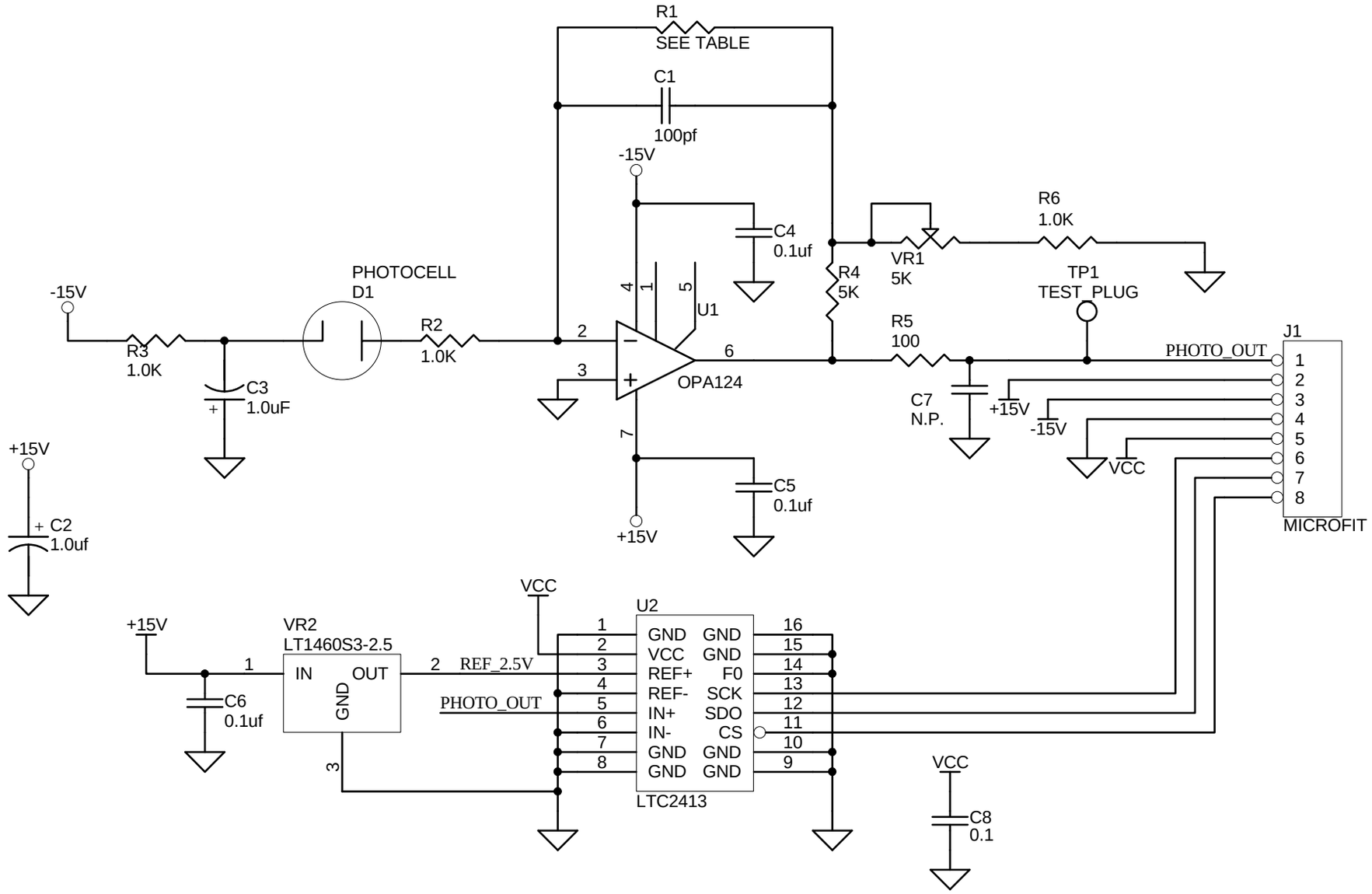
SCALE NONE | FILE | SHEET 1 OF 1

Revision	Description					Checked	Date	DCN	
A	Initial Release					KV	1/10/2007	4328	

		CONNECTION FROM				CONNECTION TO			
Cable Part #	Signal	Assembly	PN	J/P	Pin	Assembly	PN	J/P	Pin
007290000	**CBL, KEYBOARD/DISPLAY**								
	D7	Display	DS_9	CN1	1	Keyboard/Interface	04258	J3	1
	D6	Display	DS_9	CN1	2	Keyboard/Interface	04258	J3	2
	D5	Display	DS_9	CN1	3	Keyboard/Interface	04258	J3	3
	D4	Display	DS_9	CN1	4	Keyboard/Interface	04258	J3	4
	D3	Display	DS_9	CN1	5	Keyboard/Interface	04258	J3	5
	D2	Display	DS_9	CN1	6	Keyboard/Interface	04258	J3	6
	D1	Display	DS_9	CN1	7	Keyboard/Interface	04258	J3	7
	D0	Display	DS_9	CN1	8	Keyboard/Interface	04258	J3	8
	DISP WRITE	Display	DS_9	CN1	9	Keyboard/Interface	04258	J3	9
	DGND	Display	DS_9	CN1	10	Keyboard/Interface	04258	J3	10
	Spare	Display	DS_9	CN1	11	Keyboard/Interface	04258	J3	11
	DISP_BUSY	Display	DS_9	CN1	12	Keyboard/Interface	04258	J3	12
	DISP_RETURN	Display	DS_9	CN1	13	Keyboard/Interface	04258	J3	13
	DISP_RETURN	Display	DS_9	CN1	14	Keyboard/Interface	04258	J3	14
	DISP_PWR	Display	DS_9	CN1	15	Keyboard/Interface	04258	J3	15
	DISP_PWR	Display	DS_9	CN1	16	Keyboard/Interface	04258	J3	16
0364901	**CBL, AC Power, E-series**								
	AC Line	Power Entry	CN0000073		L	Power Switch	SW0000051		L
	AC Neutral	Power Entry	CN0000073		N	Power Switch	SW0000051		N
	Power Grnd	Power Entry	CN0000073			Shield	SW0000051		
	Power Grnd	Power Entry	CN0000073			Chassis	052590000		
	AC Line Switched	Power Switch	CN0000073		L	PS2 (+12)	PS0000038	J1	1
	AC Neutral Switched	Power Switch	CN0000073		N	PS2 (+12)	PS0000038	J1	3
	Power Grnd	Power Entry	CN0000073			PS2 (+12)	PS0000038	J1	2
	AC Line Switched	Power Switch	CN0000073		L	PS1 (+5, ±15)	PS0000037	J1	1
	AC Neutral Switched	Power Switch	CN0000073		N	PS1 (+5, ±15)	PS0000037	J1	3
	Power Grnd	Power Entry	CN0000073			PS1 (+5, ±15)	PS0000037	J1	2
	AC Line Switched	Power Switch	CN0000073		L	Relay Board	045230100	J1	1
	AC Neutral Switched	Power Switch	CN0000073		N	Relay Board	045230100	J1	3
	Power Grnd	Power Entry	CN0000073			Relay Board	045230100	J1	2
03829	**CBL, DC power to motherboard, E-series**								
	DGND	Relay Board	045230100	J7	1	Motherboard	057020400	J15	1
	+5V	Relay Board	045230100	J7	2	Motherboard	057020400	J15	2
	AGND	Relay Board	045230100	J7	3	Motherboard	057020400	J15	3
	+15V	Relay Board	045230100	J7	4	Motherboard	057020400	J15	4
	AGND	Relay Board	045230100	J7	5	Motherboard	057020400	J15	5
	-15V	Relay Board	045230100	J7	6	Motherboard	057020400	J15	6
	+12V RET	Relay Board	045230100	J7	7	Motherboard	057020400	J15	7
	+12V	Relay Board	045230100	J7	8	Motherboard	057020400	J15	8
	Chassis Gnd	Relay Board	045230100	J7	10	Motherboard	057020400	J15	9
04105	**CBL, Keyboard to Motherboard**								
	Kbd Interupt	Keyboard	042580000	J2	7	Motherboard	057020400	J106	1
	DGND	Keyboard	042580000	J2	2	Motherboard	057020400	J106	8
	SDA	Keyboard	042580000	J2	5	Motherboard	057020400	J106	2
	SCL	Keyboard	042580000	J2	6	Motherboard	057020400	J106	6
	Shld	Keyboard	042580000	J2	10	Motherboard	057020400	J106	5
041760000	**CBL, DC POWER, EOS, "E" SERIES**								
	DGND	Relay Board	045230100	J8	1	PS1 (+5, ±15)	PS0000037	J2	3
	+5V	Relay Board	045230100	J8	2	PS1 (+5, ±15)	PS0000037	J2	1
	+15V	Relay Board	045230100	J8	4	PS1 (+5, ±15)	PS0000037	J2	6
	AGND	Relay Board	045230100	J8	5	PS1 (+5, ±15)	PS0000037	J2	4
	-15V	Relay Board	045230100	J8	6	PS1 (+5, ±15)	PS0000037	J2	5
	+12V RET	Relay Board	045230100	J8	7	PS2 (+12)	PS0000038	J2	3
	+12V	Relay Board	045230100	J8	8	PS2 (+12)	PS0000038	J2	1
042110000	**CBL, MTHBD TO CPU,(04069, CP26)(KB)**								
	RXD(0)	CPU	CP_26	CN3	3	Motherboard	040690100	J12	14
	RTS(0)	CPU	CP_26	CN3	4	Motherboard	040690100	J12	13
	TXD(0)	CPU	CP_26	CN3	5	Motherboard	040690100	J12	12
	CTS(0)	CPU	CP_26	CN3	6	Motherboard	040690100	J12	11
	GND(0)	CPU	CP_26	CN3	9	Motherboard	040690100	J12	10
	RXD(1)	CPU	CP_26	CN4	3	Motherboard	040690100	J12	9
	RTS(1)	CPU	CP_26	CN4	4	Motherboard	040690100	J12	8
	TXD(1)	CPU	CP_26	CN4	5	Motherboard	040690100	J12	7
	CTS(1)	CPU	CP_26	CN4	6	Motherboard	040690100	J12	6
	GND(1)	CPU	CP_26	CN4	9	Motherboard	040690100	J12	5
	485+	CPU	CP_26	CN5	2	Motherboard	040690100	J12	9
	485-	CPU	CP_26	CN5	4	Motherboard	040690100	J12	7
	GND	CPU	CP_26	CN5	6	Motherboard	040690100	J12	5
	Shield					Motherboard	040690100	J12	2
042790100	**CBL, Heater/Thermistor**								
	+12V RET	Relay Board	045230100	J19	1	Lamp HTR/Thrm	041440000		1
	+12V	Relay Board	045230100	J19	2	Lamp HTR/Thrm	041440000		2
	+5VANA	Motherboard	057020400	J27	6	Lamp HTR/Thrm	041440000		3
	THERMISTOR 3	Motherboard	057020400	J27	13	Lamp HTR/Thrm	041440000		4
	+5VANA	Motherboard	057020400	J27	7	Sample Therm	042010000		1
	THERMISTOR 2	Motherboard	057020400	J27	14	Sample Therm	042010000		2
	THERMISTOR 4	Motherboard	057020400	J27	12	O3 Gen HTR/Therm	041440100		6
	+5VANA	Motherboard	057020400	J27	5	O3 Gen HTR/Therm	041440100		5
	+12V RET	Relay Board	045230100	J14	2	O3 Gen HTR/Therm	041440100		2

M703E Interconnect Listing

		CONNECTION FROM				CONNECTION TO			
Cable Part #	Signal	Assembly	PN	J/P	Pin	Assembly	PN	J/P	Pin
	+12V	Relay Board	045230100	J14	1	O3 Gen HTR/Therm	041440100		1
042800100	**CBL, PWR & SIGNAL DISTRIBUTION, 703**								
	CH1	Motherboard	057020400	J109	6	UV Det - Bench	041200000	P3	1
	AGND	Motherboard	057020400	J109	12	UV Det - Bench	041200000	P3	4
	+15V	Relay Board	045230100	J5	4	Bench Lamp Supply	041200000	P3	2
	-15V	Relay Board	045230100	J5	6	Bench Lamp Supply	041200000	P3	3
	+12V RET	Relay Board	045230100	J5	7	Fan	040010000	P1	1
	+12V	Relay Board	045230100	J5	8	Fan	040010000	P1	2
	CH6	Motherboard	057020400	J109	2	Photo Press/Flo	040030700	P1	4
	CH4	Motherboard	057020400	J109	3	Photo Press/Flo	040030700	P1	2
	CH7	Motherboard	057020400	J109	1	Photo Press/Flo	040030700	P1	5
	AGND	Relay Board	045230100	J9	3	Photo Press/Flo	040030700	P1	3
	+15V	Relay Board	045230100	J9	4	Photo Press/Flo	040030700	P1	6
	DGND	Relay Board	045230100	J9	1	Keyboard	042580000	P1	8
	VCC	Relay Board	045230100	J9	2	Keyboard	042580000	P1	1
	DGND	Relay Board	045230100	J12	1	Keyboard	042580000	P1	2
	VCC	Relay Board	045230100	J12	2	Keyboard	042580000	P1	3
	+15V	Relay Board	045230100	J12	4	IZ Det	041200000	P3	2
	-15V	Relay Board	045230100	J12	6	IZ Det	041200000	P3	3
	CH2	Motherboard	057020400	J109	5	IZ Det	041200000	P3	1
	AGND	Motherboard	057020400	J109	11	IZ Det	041200000	P3	4
054840000	**CBL, Valve driver & pump power**								
	+12V	Relay Board	045230100	J4	1	Photo Ref Valve	055220000	1	
	+12V RET	Relay Board	045230100	J4	2	Photo Ref Valve	055220000	2	
	+12V	Relay Board	045230100	J4	3	O3 Valve	055220000	1	
	+12V RET	Relay Board	045230100	J4	4	O3 Valve	055220000	2	
	+12V	Relay Board	045230100	J4	5	Pump	047020000	1	
	+12V RET	Relay Board	045230100	J4	6	Pump	047020000	2	
056310100	**CBL, I2C SIGNAL, 703E**								
	DGND	Ethernet Board	043940000	PL102	1	Relay Board	045230100	J5	1
	+5V	Ethernet Board	043940000	PL102	2	Relay Board	045230100	J5	2
	+15V	IZS Lamp Supply	041660100	P1	1	Relay Board	045230100	J5	4
	AGND	IZS Lamp Supply	041660100	P1	2	Relay Board	045230100	J5	3
	SCL	IZS Lamp Supply	041660100	P1	3	Relay Board	045230100	J3	1
	SDA	IZS Lamp Supply	041660100	P1	4	Relay Board	045230100	J3	2
	Shield	Motherboard	057020400	J107	6	Relay Board	045230100	J3	5
	SCL	IZS Lamp Supply	041660100	P1	3	Bench Lamp Supply	041660500	P1	3
	SDA	IZS Lamp Supply	041660100	P1	4	Bench Lamp Supply	041660500	P1	4
	SCL	Motherboard	057020400	J107	3	Bench Lamp Supply	041660500	P1	3
	SDA	Motherboard	057020400	J107	5	Bench Lamp Supply	041660500	P1	4
	+15V	Relay Board	045230100	J10	4	Bench Lamp Supply	041660500	P1	1
	AGND	Relay Board	045230100	J10	3	Bench Lamp Supply	041660500	P1	2
56730000	**CBL, PUMP ADAPTER, M703E**								
	115VAC	Relay Board	045230100	J2	1	Pump	047020000		1
	230VAC	Relay Board	045230100	J2	5	Pump	047020000		2
	Neutral	Relay Board	045230100	J2	2	Pump	047020000		3
	Jumper	Relay Board	045230100	J2	3	Relay Board	045230100	J2	4



PCA VERSION TABLE

PCA#	R1
04120-0000	4.99M
04120-0200	2.0M

TELEDYNE
INSTRUMENTS
Advanced Pollution Instrumentation

The information herein is the property of API and is submitted in strictest confidence for reference only. Unauthorized use by anyone for any other purposes is prohibited. This document or any information contained in it may not be duplicated without proper authorization.

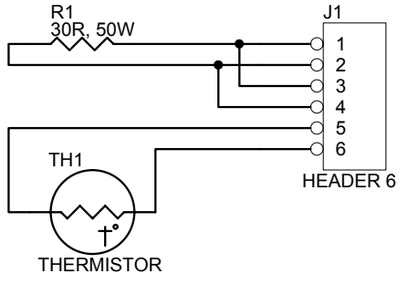
APPROVALS	DATE
DRAWN	
CHECKED	
APPROVED	

PCA, UV DETECTOR PREAMP

USA

SIZE	DRAWING NO.	REVISION
A	**04420**	**B**

LAST MOD.	SHEET
3-Aug-2004	1 of 1



Rev	Date	Change Description	Eng
A	8/1/02	Initial release for PCA schematic	KL

TELEDYNE
INSTRUMENTS
Advanced Pollution Instrumentation

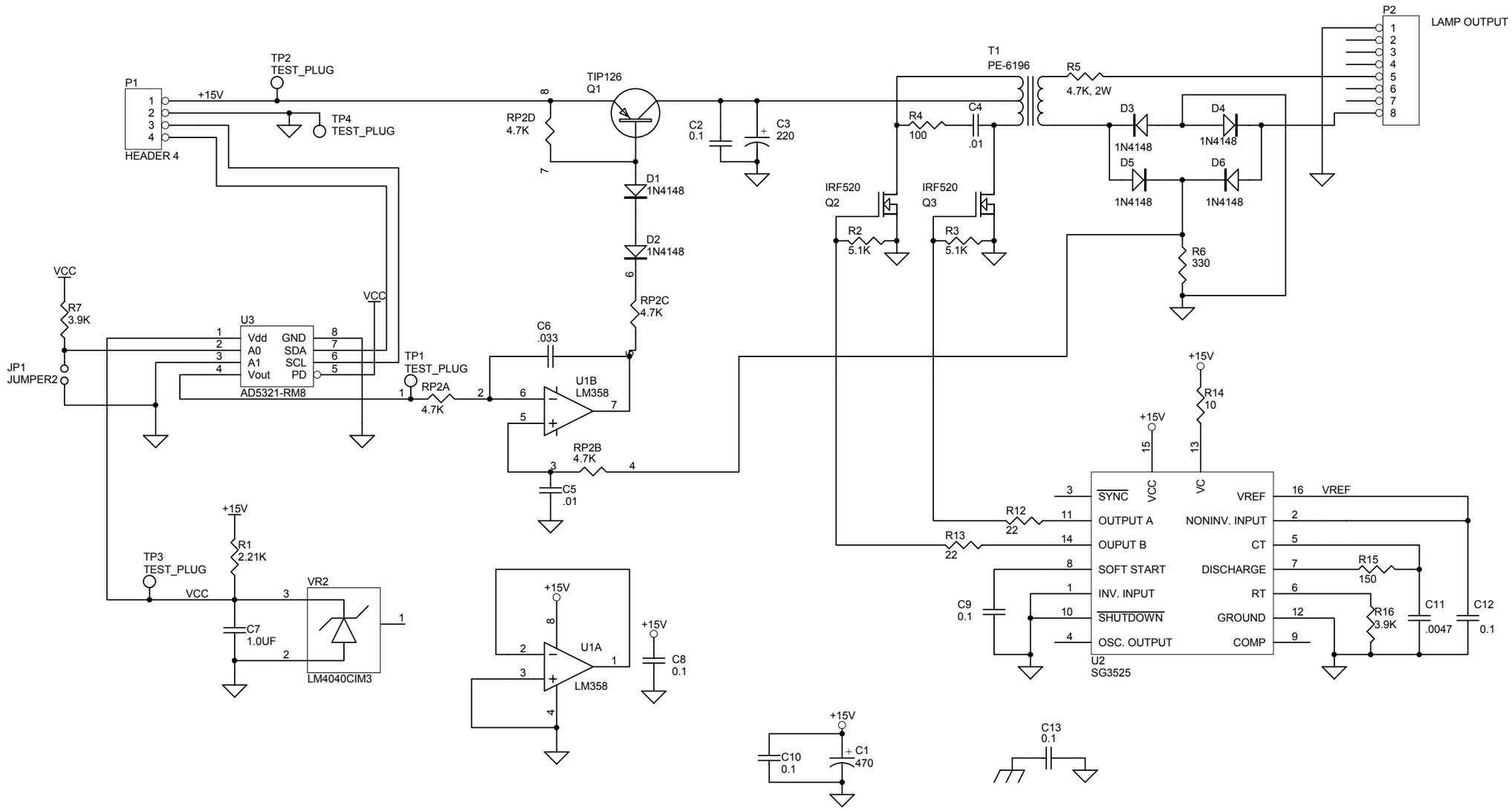
The information herein is the property of API and is submitted in strictest confidence for reference only. Unauthorized use by anyone for any other purposes is prohibited. This document or any information contained in it may not be duplicated without proper authorization.

APPROVALS	DATE
DRAWN	
CHECKED	
APPROVED	

SCH, DC HEATER/THERMISTOR

SIZE	DRAWING NO.	REVISION
B	**04422**	**A**

LAST MOD.	SHEET
1-Aug-2002	**1** of **1**



NOTE: THIS SCHEMATIC APPLIES TO THE FOLLOWING PCA'S:

PCA#	NOTE
04166-0000	M400E BENCH AND IZS LAMP SUPPLY SHUNT INSTALLED IN J1 FOR BENCH SUPPLY SHUNT NOT INSTALLED IN J1 FOR IZS SUPPLY

CHANGE NOTES

REV.	DATE	CHANGE DESCRIPTION	INITIAL
A	8/1/02	INITIAL RELEASE	KL

TELEDYNE
INSTRUMENTS
Advanced Pollution Instrumentation

The information herein is the property of API and is submitted in strictest confidence for reference only. Unauthorized use by anyone for any other purposes is prohibited. This document or any information contained in it may not be duplicated without proper authorization.

APPROVALS	DATE	SCH, UV LAMP DRIVER, M450		
DRAWN KL	3/4/97			
CHECKED		SIZE B	DRAWING NO. 04421	REVISION A
APPROVED		LAST MOD. 1-Aug-2002	SHEET 1 of 1	

M1 M2 M3 M4 M6 M5 M7 M9 M8 M10 MF3 MF4

S8 S7 S6 S5 S4 S3 S2 S1 S9 RI-1000 ONLY

VCC

U1 74C923

C1 .1uF C6 10uF

KEYBOARD, LED & HORN

U2 PCF8575

KBD_A0 KBD_A1 KBD_A2 INT SCL SDA

MAINT_SW LANG_SELCT GRN LED YEL LED RED LED LED 4 LED 5 LED 6 HORN SPR_I/O_0

DS1 GRN DS2 YEL DS3 RED DS4 DS5 DS6 RI-1000 ONLY

RN3 220 MAINT_LED_V+

A1 SONALERT

Layout Instructions:

1. Minimum trace width 8 mil would like to have 10 mil traces if possible.
2. Please run traces on both and backside but where possible fill one side with GND.
3. Minimum width for +5_DISP, DISP_PWR, DISP_RET is 40 mil, except to test points.
4. Minimum width for VCC, GND, Vdd, Vss is 30 mil, except to test points

RN1 4.7K R2 1.0K C7 300pF

U3A MM74HC74A

U3B MM74HC74A KYBRD_INT

OPT. MAINT SWITCH S12 T8201

J4 3M-2514-6002UB

MAINT SW MAINT SW RET MAINT LED V+ MAINT LED LANG SW LANG SW RET SPR I/O_0 SPR I/O RET SPR I/O_1 SPR I/O RET SPR I/O_2 SPR I/O RET

MAINT_SW MAINT_LED_V+ MAINT_LED LANG_SELCT SPR_I/O_0 SPR_I/O_1 SPR_I/O_2

OPT. LANG. SWITCH S13

RN5 4.7K

KBD_A0 KBD_A1 KBD_A2 DISP_CN_A0 DISP_CN_A1 DISP_CN_A2

JP1 ADRS SLCTS

DISP_DA_A0 DISP_DA_A1 DISP_DA_A2

JP2 I2C TERMINATION SCL SDA

DEFAULT ADDRESS SELECTS FOR I2C TO PARALLEL DECODERS:

KEYBOARD (KBD_A0 - A2)
1 1 1

DISPL CONTROL (DISP_CN_A0 -A1)
0 1 1

DISP_PWR_EN must be high for display to be powered.

NOTES:
1. This schematic is based on the PWB PN, 03974 and applies to PCA PN, 03975

R3 4.7K R4 4.7K

TP1 GND TP2 VCC TP3 +5_DISP TP4 SDA TP5 KYBRD INT

TP6 DISP_PWR TP7 DISP_RET TP8 BUSY TP9 SCL

J1 JP3 J2 JP4

C11 220pF C12 220pF C10 220pF C14 100uF C4 .1uF DISP_RET

C9 220pF C8 220pF C13 10uF C2 .1uF C3 .1uF C5 .1uF C15 .1uF C16 .1uF

U4 PCF8574 DISPLAY DATA

DISP_DA_A0 DISP_DA_A1 DISP_DA_A2 SCL SDA

J3 TO/FRM DISPLAY

DISP_WR DISP_BUSY DISP_RET

C17 1500uF +5_DISP

U5 PCF8574 DISPLAY CONTROL

DISP_CN_A0 DISP_CN_A1 DISP_CN_A2 SCL SDA

DISP_WR DISP_BUSY DISP_PWR_EN MAINT_LED SPR_I/O_1 SPR_I/O_2

RN2 4.7K

U6 MCP120T 4.85V DTCT

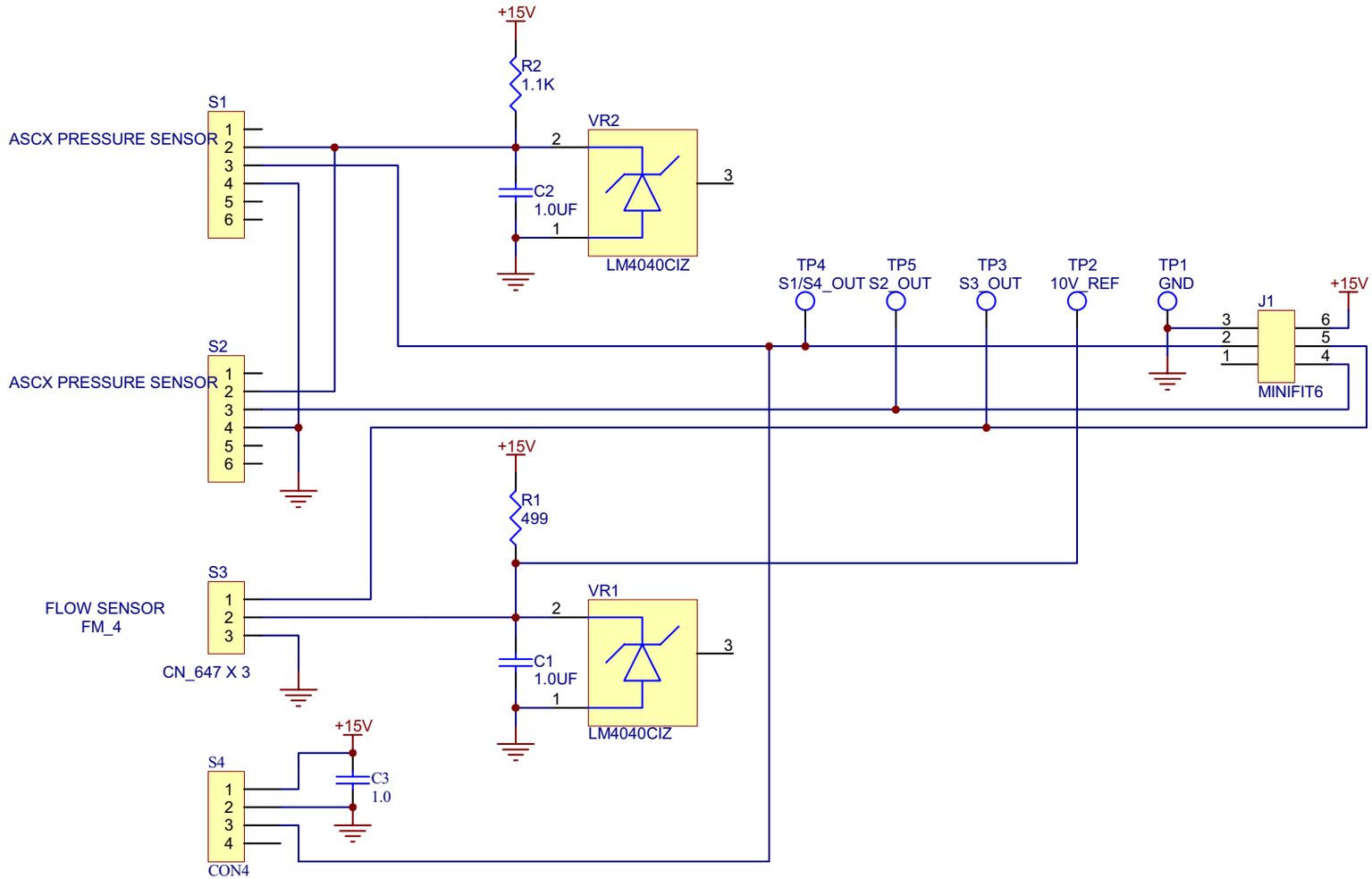
R20 1K

Q2 MMBT3904

Q1 SI3443DV DISP_PWR +5_DISP

JP5 DISP_PWR_OVR

Title	Schematic for PCA #04258 and PCB #04257, Keyboard/Display Interface for E series		
Size B	Number 04259		Revision a
Date: 21-Mar-2002		Sheet of	
File: N:\YHWork\M300B\keyboard\04257a\04259A.ddb		Drawn By:	



TELEDYNE
INSTRUMENTS
Advanced Pollution Instrumentation

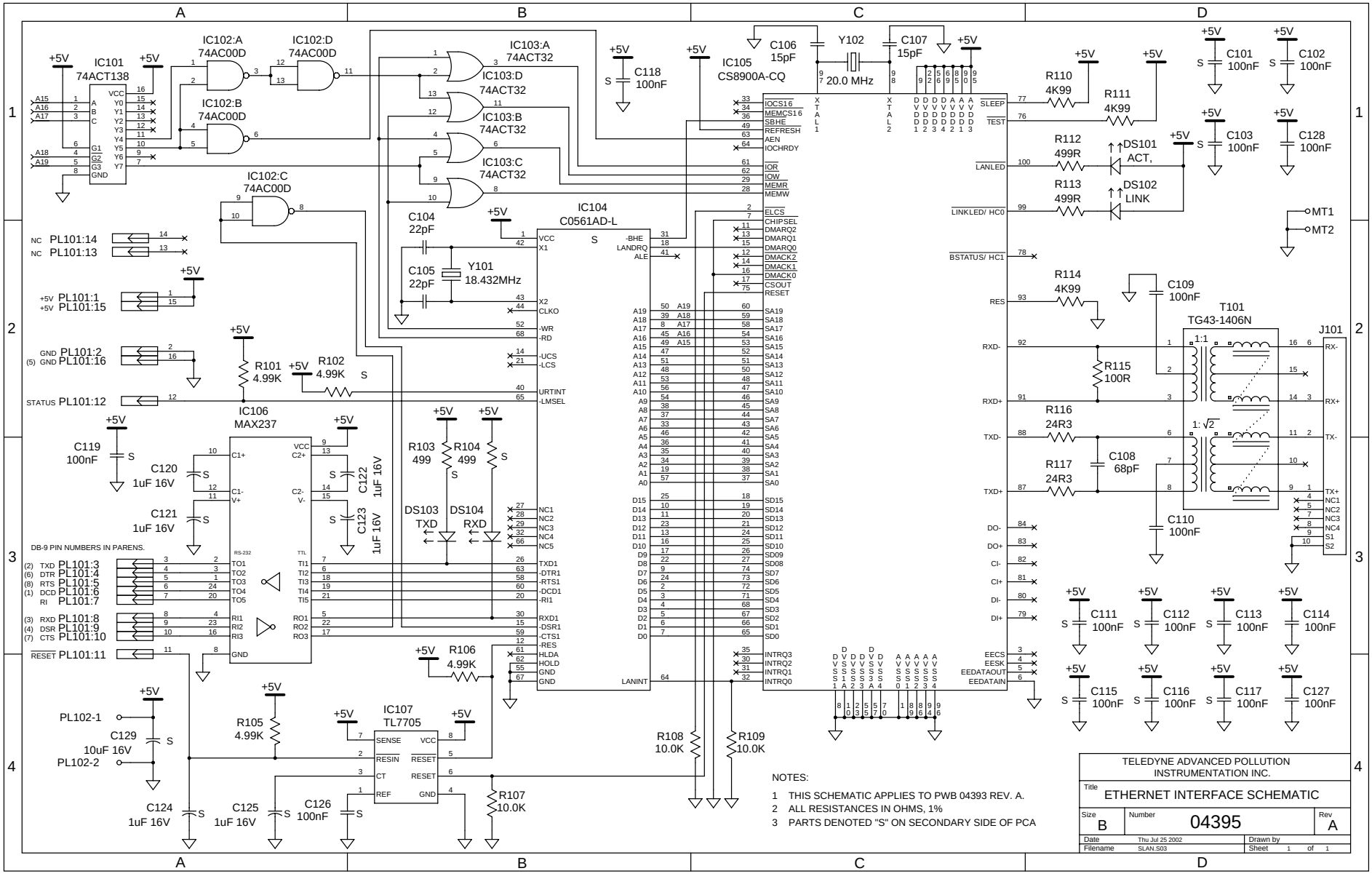
The information herein is the property of API and is submitted in strictest confidence for reference only. Unauthorized use by anyone for any other purposes is prohibited. This document or any information contained in it may not be duplicated without proper authorization.

APPROVALS	DATE
DRAWN	
CHECKED	
APPROVED	

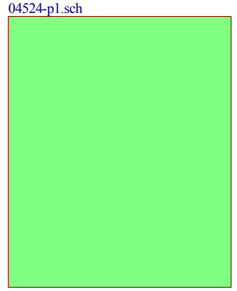
SCH, PCA 04003, PRESS/FLOW, 'E' SERIES

SIZE	DRAWING NO.	REVISION
B	04354	D

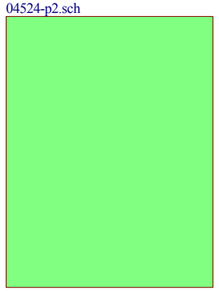
LAST MOD.	SHEET
3-Dec-2007	1 of 1


IC101 74ACT138
IC102:A 74AC00D
IC102:B 74AC00D
IC102:C 74AC00D
IC102:D 74AC00D
IC103:A 74ACT32
IC103:B 74ACT32
IC103:C 74ACT32
IC103:D 74ACT32
IC104 C0561AD-L
IC105 CS8900A-CQ
IC106 MAX237
IC107 TL7705
Y101 18.432MHz
Y102 20.0 MHz
C101 100nF
C102 100nF
C103 100nF
C104 22pF
C105 22pF
C106 15pF
C107 15pF
C108 68pF
C109 100nF
C110 100nF
C111 100nF
C112 100nF
C113 100nF
C114 100nF
C115 100nF
C116 100nF
C117 100nF
C118 100nF
C119 100nF
C120 1uF 16V
C121 1uF 16V
C122 1uF 16V
C123 1uF 16V
C124 1uF 16V
C125 1uF 16V
C126 100nF
C127 100nF
C128 100nF
C129 10uF 16V
R101 4.99K
R102 4.99K
R103 499
R104 499
R105 4.99K
R106 4.99K
R107 10.0K
R108 10.0K
R109 10.0K
R110 4K99
R111 4K99
R112 499R
R113 499R
R114 4K99
R115 100R
R116 24R3
R117 24R3
T101 TG43-1406N
J101
DS101 ACT,
DS102 LINK
DS103 TXD
DS104 RXD
MT1
MT2
DB-9 PIN NUMBERS IN PARENS.
+5V
NOTES:
1 THIS SCHEMATIC APPLIES TO PWB 04393 REV. A.
2 ALL RESISTANCES IN OHMS, 1%
3 PARTS DENOTED "S" ON SECONDARY SIDE OF PCA
TELEDYNE ADVANCED POLLUTION INSTRUMENTATION INC.
Title ETHERNET INTERFACE SCHEMATIC
Size B
Number 04395
Rev A
Date Thu Jul 25 2002
Filename SLAN.S03
Drawn by
Sheet 1 of 1

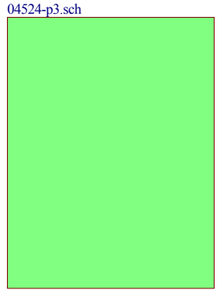
Name
04524-p1.sch



Name
04524-p2.sch



Name
04524-p3.sch



Title	M100E/200E/400E RELAY PCA SCHEMATIC	
Size: B	Number: 04522	Revision: D
Date: 16-May-2007	Sheet 0 of 0	
File: N:\PCBMGR\04522cc\source\04522dd.sch	Drawn By:	

Te

Te

General Trace Width Requirements
1. Vcc (+5V) and I2C VCC should be 15 mil
2. Digitial grounds should be at least 20 mils
3. +12V and +12V return should be 30 mils
4. All AC lines (AC Line, AC Neutral, RELAY0 - 4, All signals on JP2) should be 30 mils wide, with 120 mil isolation/creepage distance around them
5. Traces between J7 - J12 should be top and bottom and at least 140 mils.
6. Traces to the test points can be as small as 10 mils.

J1 4 PIN — AC_Line, AC_Neutral

VCC — R1 2.2K, R2 2.2K

JP1 HEADER 4X2

RN1 330 — I2C_Vcc

RELAY0, RELAY1, RELAY2 — K1, K2, K3 — SLD-RLY

D1 WDOG, D2 RED, D3 YEL RL0, D4 YEL RL1, D7 YEL RL2, D8 GRN VA0, D9 GRN VA1, D10 GRN VA2, GRN VA3

C1 0.1

U1 PCF8575 — A0, A1, A2, INT, SCL, SDA, Vdd, Vss, P00–P07, P10–P17, IO3–IO15

J3 CON5

U2A, U2B, U2C, U2D, U2E — SN74HC04

Q1 IRF7205 — R3 20K, R5 10K, R6 10K

U4 MAX693 — VBATT, VOUT, VCC, GND, BATT_ON, LOW_LINE', OSC IN, OSC SEL, RESET, RESET', WDO', CD IN', CD OUT', WDI, PFO', PFI

C2 0.001, C3 1, C4 10/16, C5 10/16

D17 DL4148, R4 1M

JP4 WTCDG OVR

JP3 HEADER 1X2 — DC PWR IN

VLV_ENAB

JP2 Heater Config Jumper — TS0, TS1, TS2, AC_Neutral

J2 16 PIN — COMMON0, LOAD0, TS0, RELAY0, COMMON1, LOAD1, TS1, RELAY1, COMMON2, LOAD2, TS2, RELAY2

+12V — F1, F2 4A PTC INTERRUPTOR — DD4, DD1 6A RECTIFIER — VALVE_POWER

U5 UDN2540B(16) — IN 4, IN 3, ENABLE, IN 2, IN 1, VCC, GND, OUT4, K, OUT 3, OUT 2, K, OUT 1

J4 8 PIN — VALVE0, VALVE1, VALVE2, VALVE3

C16 22 uF, C6 2000/25 find low ESR electroytic, DD2 15V TVS — +12RET

J5 CON10THROUGH — DGND, VCC, AGND, +15V, AGND, -15V, +12RET, +12V, EGND, CHS_GND

J7 KEYBRD, J8 MTHR BRD, J9 SYNC DEMOD, J10 SPARE, J11, J12, J13 — CON10THROUGH

TP1 DGND, TP2 +5V, TP3 AGND, TP4 +15V, TP5 -15V, TP6 +12RT, TP7 +12V

Printed documents are uncontrolled

REV	AUTH	DATE	
B	CAC	10/3/02	CE MARK LINE VOLTAGE TRACE SPACING FIX
D	RJ	5/16/07	Add alternate thermocouple connectors

Title: Schem, M100E/M200E/M400E Relay PCB
Size: B
Number: 04524
Revision: D
Date: 16-May-2007
Sheet 1 of 3
File: N:\PCBMGR\04522cc\source\04522d.dsn
Drawn By:

AC_Line
RELAY3
RELAY4
RN2
330
I2C_Vcc
RELAY3
RELAY4
K4
K5
SLD-RLY
SLD-RLY
D5 YEL
D6 YEL
D11 GRN
D12 GRN
D13 GRN
D14 GRN
D15 GRN
D16 GRN
RL3
RL4
VA4
VA5
VA6
VA7
TR0
TR1
IO3
IO4
IO10
IO11
IO12
IO13
IO14
IO15
U3A
SN74HC04
U3D
U3E
U3C
U3B
U3F
U2F
VCC
C13
0.1
VLV_ENAB
Q2
IRL3303
Q3
IRL3303
Q4
IRL3303
+12RET
Use 50 mil traces
J19
MINIFIT-2
J14
MINIFIT-2
J21
MINIFIT-2
+12V

JP6
Heater Config Jumper
TS3
TS4
AC_Neutral

Aux Relay Connector
J18 16 PIN
COMMON3
LOAD3
TS3
RELAY3
COMMON4
LOAD4
TS4
RELAY4
RELAY3
RELAY4

JP7
MINI-FIT 10
AC_Neutral
AC_Line
PUMP
J20

JP7 Configuration

Standard Pumps	World Pumps
60 Hz: 3-8	60Hz/100-115V: 3-8, 4-9, 2-7
50 Hz: 2-7, 5-10	50Hz/100-115V: 3-8, 4-9, 2-7, 5-10
	60Hz/220-240V: 3-8, 1-6
	50Hz/220-240V: 3-8, 1-6, 5-10

VCC
U6
UDN2540B(16)
IN 4
IN 3
ENABLE
IN 2
IN 1
OUT4
OUT 3
OUT 2
OUT 1
VALVE_POWER
J6
Valve4
Valve5
Valve6
Valve7
CON14
DD3
15V TVS
C17
22 uF

Printed documents are uncontrolled

Title	Schem, M100E/M200E/M400E Relay PCB		
Size B	Number 04524	Revision D	
Date: 16-May-2007	Sheet 2 of 3		
File: N:\PCBMGR\04522cc\source\04522d.dsn	Drawn By:		

THERMOCOUPLE CONNECTOR
OMEGA
J15
J15A
THERMOCOUPLE CONNECTOR
HAMITHERM
F3
1/8 AMP FUSE
F4
1/8 AMP FUSE
R19
3M
-15V
TC1_GNDTCA
TC1_GND
R15
10K
ZR2
3V
ZR1
3V
R13
10K
TC1_KCOMPA
TC1_JCOMPA
R23
6.81K
C12
0.01
TC1_GND
+15V
C7
0.1
U7A
OPA2277
C10
0.1
-15V
0.01
C8
R21
1k
R25
14K
TC1_JGAINA
R17
5K
CW
R9
10K
R11
1M
TC1_5MVA
TC1_5MVB
1M
R10
R7
20K
TC1_JGAINB
ZR3
4.7V
J17
MICROFIT-4
U8
Vin
TOUT
J
K
R-
Gnd
LT1025
C9
0.1
JP5
MICROFIT-20
TC PROGRAMMING SOCKET
TC1_JGAINA
TC1_5MVA
TC1_JCOMPA
TC1_KCOMPA
TC1_GNDTCA
TC2_JGAINA
TC2_5MVA
TC2_JCOMPA
TC2_KCOMPA
TC2_GNDTCA
TC1_JGAINB
TC1_5MVB
TC1_JCOMPB
TC1_KCOMPB
TC1_GNDTCB
TC2_JGAINB
TC2_5MVB
TC2_JCOMPB
TC2_KCOMPB
TC2_GNDTCB

* GROUNDED THERMOCOUPLES ARE EXPECTED BY DEFAULT
No extra connections are necessary for grounded thermocouples
* FOR UNGROUNDED THERMOCOUPLES
short TCX_GNDTCA to TCX_GNDTCB
* FOR K THERMOCOUPLE:
1) Install CN0000156 for thermocouple connector
2) Short only TCX_KCOMPA to TCX_KCOMPB on TC Programming Plug
4) Leave TCX_JCOMPX pins of the plug unconnected
* FOR J THERMOCOUPLE:
1) Install CN0000155 for thermocouple connector
2) Short TCX_JCOMPA to TCXJCOMPB on TC Programming Plug
3) Short TCX_JGAINA to TCX_JGAINB on TC Programming Plug
4) Leave TCX_KCOMPX pins of the plug unconnected
* DEFAULT OUTPUT IS 10 mV PER DEG C

THERMOCOUPLE CONNECTOR
OMEGA
J16
J16A
THERMOCOUPLE CONNECTOR
HAMITHERM
F5
1/8 AMP FUSE
F6
1/8 AMP FUSE
R20
3M
-15V
TC2_GNDTCA
TC2_GND
R16
10K
ZR5
3V
ZR6
3V
R18
10K
TC2_KCOMPA
TC2_JCOMPA
R24
6.81K
C15
0.01
TC2_GND
+15V
U7B
OPA2277
R22
1k
C11
0.01
R26
14.3K
TC2_JGAINA
R28
5K
CW
R27
10K
R14
1M
TC2_5MVA
TC2_5MVB
R12
1M
R8
20K
TC2_JGAINB
ZR4
4.7V
U10
Vin
TOUT
J
K
R-
Gnd
LT1025
C14
0.1
TC2_JCOMPB
TC2_KCOMPB

Printed documents are uncontrolled

Title	Schem, M100E/M200E/M400E Relay PCB		
Size B	Number 04524		Revision D
Date: 16-May-2007	Sheet 3 of 3		
File: N:\PCBMGR\04522cc\source\04522dd.dd	Drawn By:		

ADDR=0x360 (DEFAULT)
ADDR = 0x320 (JP1 INSTALLED)

Pins 1&2 shorted on PCA

shorted - sldr side

shorted - sldr side

0.15 uF, ceramic

1.2 uF, 6.3V ceramic

0.15 uF, ceramic

Notes:

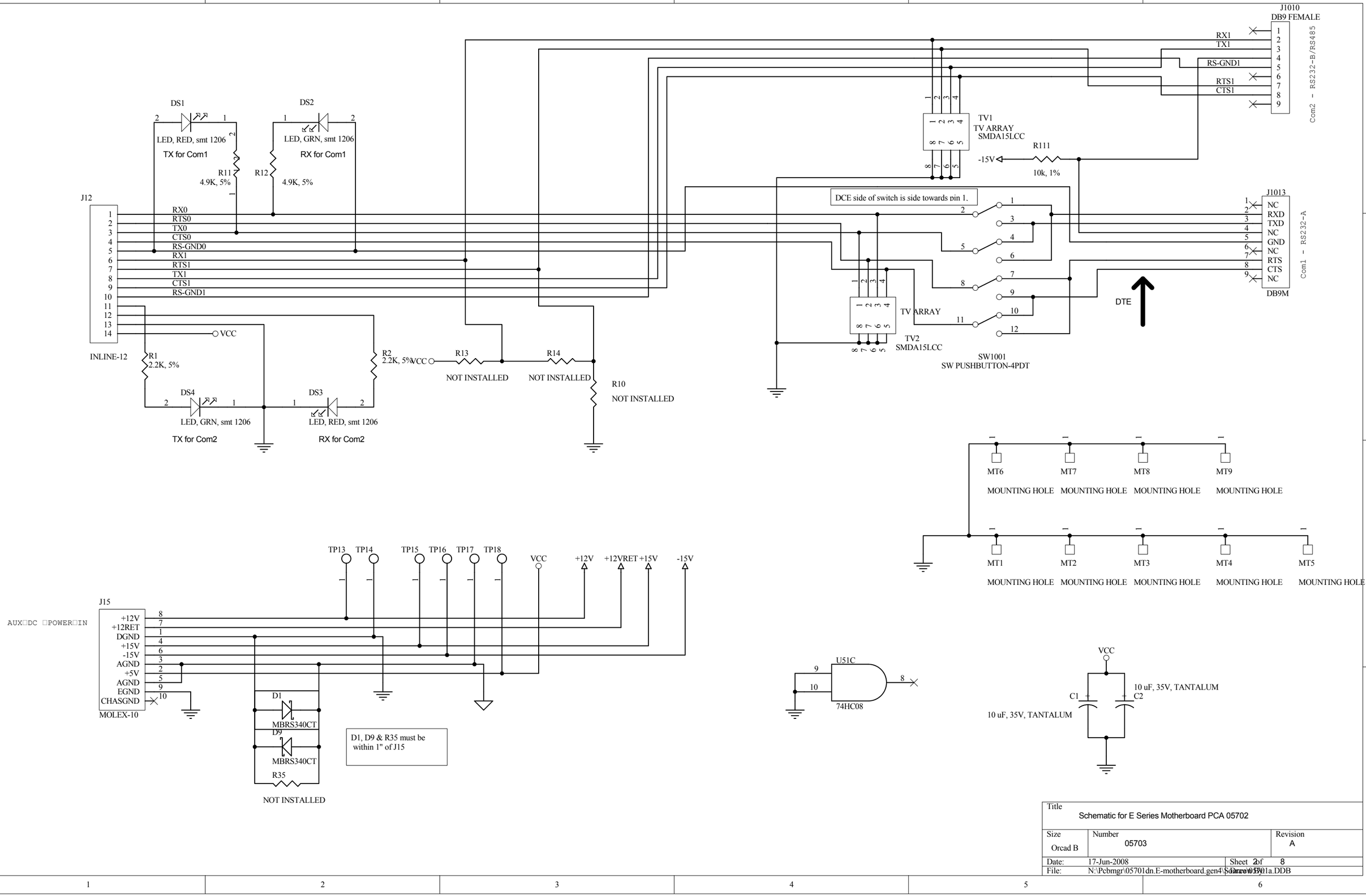
1) This schematic is for PCA #05702
2) This schematic is for PCB 05701

Title: Schematic for E Series Motherboard PCA 05702

Size	Number	Revision
Orcad B	05703	A

Date: 17-Jun-2008 Sheet 1 of 8

File: N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB



Title	Schematic for E Series Motherboard PCA 05702
Size	Orcad B
Number	05703
Revision	A
Date:	17-Jun-2008
Sheet	2 of 8
File:	N:\Pcbmgr\05701dn.E-motherboard.gen4\Schrev01a\05701a.DDB
Drawn By:	

DAC RANGE & OFFSET PROGRAM

ISOLATED 0-20MA OPTIONAL BOARDS

ANALOG VOLTAGE & CURRENT OUTPUTS

DUAL DAC A1

DUAL DAC A2

DAC 2

OP-AMP, PRECISION DUAL

OP-AMP, PRECISION QUAD

IDC-8

TV ARRAY

SMDA15LCC

FE BEAD

TERMBLOCK-8

MICROFIT-10

DAC, 12 BIT

SOCKET U31

SOCKET U33

POT, DIGITAL

74HC32

74HC574

MBRS340CT

D7 and D8
Must be located
within 1" of U32 & U34

Title	Schematic for E Series Motherboard PCA 05702
Size	Orcad B
Number	05703
Revision	A
Date:	17-Jun-2008
Sheet 3 of	8
File:	N:\Pcbmgr\05701dn.E-motherboard.gen\Documents\05701a.DDB

ANALOG INPUTS

J109 MICROFIT-12: CH7, CH6, CH4, CH3, CH2, CH1

J110 MICROFIT-12: CH14, CH13, CH12, CH11, CH9, CH8

RN14 100Kx8

RN15 100Kx8

U52 AN MUX: IN1 CH1, IN2 CH2, IN3 CH3, IN4 CH4, IN5 CH6, IN6 CH7, IN7 CH8, IN8 CH9, IN9 CH11, IN10 CH12, IN11 CH13, IN12 CH14, IN13–IN16; OUT, +VSS, -VSS, GND, VREF, NC, NC, ENB VCC, A3, A2, A1, A0

TP3 AGND

C47 1.2 uF, 6.3V ceramic

U56 VOLTAGE REF: NC, NC, VOUT, TRIM, NC, VIN, NR, GND

C48 1.2 uF, 6.3V ceramic

TP1 VREF

VREF

TEMPMUX

DACMUX

TP49

TC6

SHDN

U58 74HC574: OE, CLK, D0–D7, Q1–Q8

U59A 74HC32: CHGAIN, IOW

U59B 74HC32: VFPROG, IOW

TP50

U60 74HC574: OE, CLK, D0–D7, Q1 SA, Q2 SB, Q3 SC, Q4 START, Q5, Q6 MSB, Q7 MID, Q8 LSB

D[0..7]

SEL60

RN17 100Kx8

C55 0.15 uF, ceramic

C42 0.15 uF, ceramic 2

C43 0.15 uF, ceramic

C46 0.15 uF, ceramic

U53 OP-AMP, PRECISION

TC7

R45 induces an offset in analog signal to give a 'live 0' for sensors with 0 or slightly negative output

U55 DG444DY: S1–S4, IN1–IN4, D1–D4, VCC, -VS, GND, +VS

R47 100

R48 200

C49 0.15 uF, ceramic

R49 100

C50 10 uF, 35V, TANTALUM

R47 and R48 reduce the gain for analog inputs by 1%, so that we can read slightly above full scale, to prevent overflow of ADC reading

C40 0.15 uF, ceramic

R43 100

C41 10 uF, 35V, TANTALUM

R45 1M, 1%, 1206 CHIP

C44 .022 uF, 50V

U54 AD652KP: NC, +VS, NC, REF, NC, OP OUT, OP-, OP+, 5VI, 10VI, 8VI, OPT10V, -VS, COS, CLK, COMP+, COMP-, AGND, GND, FOUT

R46 1.1K, 5%

C45 10 uF, 35V, TANTALUM

X2 JITO-2-DCA5AE-4.8MHZ

C54 0.15 uF, ceramic

X1 MB100H-4.8MHZ

PLACE 100 OHM RESISTOR AS CLOS AS POSSIBLE TO X1 AND X2

TP48

R9 100

D6 D2 D5

U57 Xilinx CPLD: RDLSB, DB2, DB6, TIE, TIE, TIE, DB5, VFCLK, ICLK, VCCINT, TIE, DB4, RDMBYTE, DB3, GND, DB7, TIE, TIE, DB0, TDI, TMS, TCK, TIE, TIE, TIE, TIE, TIE, FREQ, TIE, TIE, VCCIO, GND, TDO, SEL60, RDMSB, TIE, DB1, VCCINT, IOR, GND, SA, SB, SC, READ, START

TP57

TC8

C51 0.15 uF, ceramic

C52 0.15 uF, ceramic

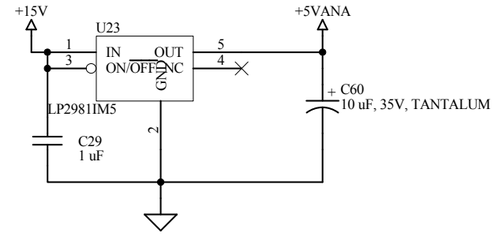
TP51 TP52 TP53 TP54 TP55

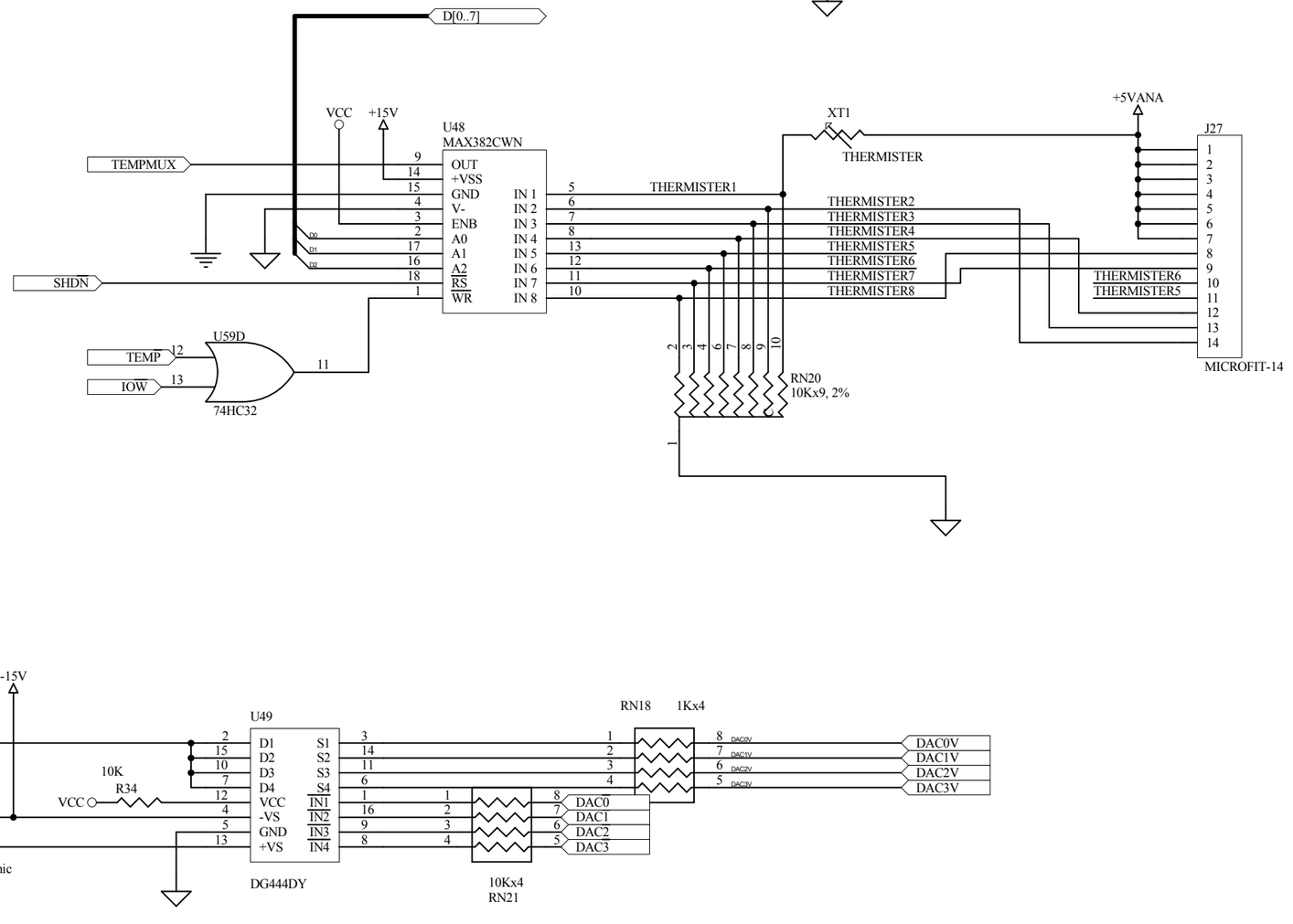
IOR

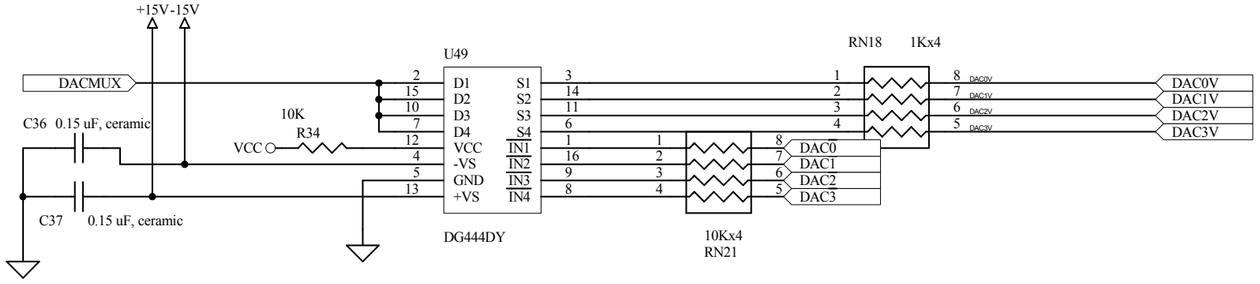
VFREAD

Title	Schematic for E Series Motherboard PCA 05702	
Size: Orcad B	Number: 05703	Revision: A
Date: 17-Jun-2008	Sheet 4 of 8	
File: N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB	Drawn by:	

BYPASS CAPS MUST BE WITHIN 1/2" OF THE REGULATOR INPUT/OUTPUT PINS







Title: Schematic for E Series Motherboard PCA 05702		
Size: Orcad B	Number: 05703	Revision: A
Date: 17-Jun-2008	Sheet 5 of 8	
File: N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB	Drawn By:	

CONTROL INPUTS

J1004
EXTERNAL CONTROL IN A
TERMBLOCK-10
L19 L20 L21 L22 FE BEAD
L8 L9
C34 C35 C56 C57 C22 C23
10000 pF
10000 pF
EXT_+5V_OUT
RN3 510x8
U12 PS2702-4
VCC
RN2 15Kx8
U11
74HC541
TP7
DIGIO0
IOR
D[0..7]
D0 D1 D2 D3 D4 D5 D6 D7
R26 100
R27 100
R28 100
R29 100
R30 100
R31 100
R32 100
R33 100
C96 C97 C98 C99 C100 C101 C102 C103
330 pF, 50V

Place these termination resistors at the end of each data line. Each data line should be laid out as a daisy-chain, the signal passing from one IC to the next.

J1006
EXTERNAL CONTROL IN B
TERMBLOCK-10
L28 L29 L30 L27 L11 L10 FE BEAD
C24 C25 C63 C64 C65 C66
10000 pF
10000 pF
EXT_+5V_OUT
RN1 510x4
U13 PS2702-4
RN4 15Kx8
U14
74HC541
DIGIO4
IOR
D[0..7]

Title	Schematic for E Series Motherboard PCA 05702		
Size: Orcad B	Number: 05703		Revision: A
Date: 17-Jun-2008	Sheet 6 of 8		
File: N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB	Drawn by:		

DIGITAL OUTPUTS

VCC
RN10
510x8
TP19
SHDN
U6B
DIGIO2
IOW
74HC32
U24
74HC574
OE
CLK
D0
D1
D2
D3
D4
D5
D6
D7
D[0..7]
U22
PS2702-4
U25
PS2702-4
L43
L44
L45
L46 FE BEAD
L48
L49
L50
L47 FE BEAD
L12
FE BEAD
C80
C82
10000 pF
C79
C81
10000 pF
C84
C86
C83
C85
C26
10000 pF
C27
J1017
TERMBLOCK-12
A STATUS OUTPUTS

RESETTABLE FUSE, 0.3A, 60V
D6
F1
L13
FE BEAD
EXT +5V_OUT
DIODE, SCHOTTKY

VCC
RN12
510x8
SHDN
U20D
DIGIO3
IOW
74HC32
U27
74HC574
U26
PS2702-4
U28
PS2702-4
L52
L53
L54
L51 FE BEAD
L56
L57
L58
L55 FE BEAD
L14
C90
10000 pF
C88
C87
C89
10000 pF
C28
C92
C94
10000 pF
C91
C93
10000 pF
J1018
B STATUS OUTPUTS
RET
GND
TERMBLOCK-10

Title	Schematic for E Series Motherboard PCA 05702	
Size: Orcad B	Number: 05703	Revision: A
Date: 17-Jun-2008	Sheet 7 of 8	
File: N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB	Drawn By:	

DIGITAL OUTPUTS

VCC
RN7
510x8
U16 PS2702-4
U17
74HC574
SHDN
U59C
DIGIO0
IOW
74HC32
D[0..7]
L32
L33
L34
L31 FE BEAD
10000 pF
C67
C68
C69
C70
J1008
CONTROL OUTPUTS
U18 PS2702-4
L36
L37
L38
L35 FE BEAD
CO_EXT_RET
TERMBLOCK-14
EXTERNAL CONNECTOR SOLDER SIDE
L59 FE BEAD
C95
C71
C72
C73
C74
10000 pF
VCC
RN5
510x8
U19 PS2702-4
SHDN
U20A
DIGIO4
IOW
74HC32
U21
74HC574
L40
L41
L42
L39 FE BEAD
C75
C76
C77
C78
10000 pF
+12V
D2
DIODE, SCHOTTKY
K1
RELAY SPDT
J1009
EXTERNAL REAR PANEL ALARM OUTPUTS
Q1
R58
2.2K, 5%
SO2222
12V
D3
DIODE, SCHOTTKY
K2
RELAY SPDT
Q2
R6
2.2K, 5%
SO2222
+12V
D4
DIODE, SCHOTTKY
K3
RELAY SPDT
Q3
R7
2.2K, 5%
SO2222
+12V
D5
DIODE, SCHOTTKY
K4
RELAY SPDT
Q4
R8
2.2K, 5%
SO2222
TERMBLOCK-12
+12VRET

Title	Schematic for E Series Motherboard PCA 05702
Size	Orcad B
Number	05703
Revision	A
Date:	17-Jun-2008
Sheet	8 of 8
File:	N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB
Drawn by:	